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SCIENCE AND SOCIAL PIONEERING

THE first British and American Association Lecture was to have been delivered at Dundee on September 5 by Dr. Isaiah Bowman, who had chosen the title "Science and Social Pioneering" for his lecture. Circumstances prevented its delivery, but it is available in printed form, and it provides a thoughtful analysis of views on the contribution of science to social welfare and to that process of continuously planned advance across the threshold of experience which may well be called social pioneering.

The opinions as to the extent to which science has added to man's cultural possibilities, given him a better way of thinking through his difficulties, or raised his hopes for a more ethical civilization, which Dr. Bowman has collected from American sources outside the ranks of science, are largely to be met in Great Britain and in France also, both within and without the ranks of scientific workers. Science, it is at last being realized, is a part of human life, not something separate and distinct. As human experience, it is not universal, a summation of knowledge applicable and useful to the whole of life; it is rather a thing of limited categories, a special form of human interests.

To most men of science, science is only a specialized form of experience, but the study of the background of social life against which science has developed raises problems foreign to this outlook. Any serious attempt to probe back to the social origins and social consequences of scientific discovery demands that scientific workers shall at least make an effort to guard against the dangers of their own specialization. To be fully scientific, they must be aware not only of their own point of advance but also of the advancing front of science.

We should not indeed despise specialization, and Dr. Bowman points out that specialization has increased the satisfaction of many of our fundamental material needs. If the spiritual gains at the moment seem in deplorable contrast to the material benefits, it should be remembered that one of the greatest achievements of science is its emphasis upon free inquiry—the mind itself in command, driven by curiosity and the sense of adventure. Civilization itself can well be considered an adventure in change, and science has become one of the greatest adventures of our time, partly because it deals with the edge of the possibilities. Man is changing his own possibilities as well as those of his world as he goes along. He is at the centre of his own creative experiment. What science supplies is not at all an addition, positive and beneficial, until men have proved it so, and with the addition of things and forces, social and natural, good and bad, ever new possibilities are emerging.

This insistence on the spirit of adventure is indeed one of the keynotes of Dr. Bowman's address. The new frontiers opened up by science in old communities make demands on the spirit of man not less than those made in the pioneering days in a new continent. The play of forces involved in the far-reaching movements and cultural changes of a scientific age, whether self-initiated and free or guided by government, represents a development of high interest in the social field. Vital leadership, courage and local pride as well as equipment and the experimental point of view are required.

Moreover, we have to remember that what we gather of scientific knowledge concerning society and how it might be improved form one set of

data; to persuade or to exercise control to bring about desired ends is quite another. Society is built upon beliefs, traditions, prejudices, suppositions and philosophies as well as facts, institutions, inventions and material—all supported by power or force exercised through time. Every advance in applied science calls for a tighter and more inclusive social organization, and while in democratic countries the adoption or rejection of ideas may be freely debated or contested, it is premature to suppose that even democracy ensures continued freedom.

What Dr. Bowman terms social pioneering is concerned with culture in the making, with environment that becomes understood through thinking about the conditions of trial and the effects of error. It deals with new social forms or old forms adapted to new situations, and becomes ever more complex and overpowering for the individual. Such conditions naturally make planning more uncertain, because of unpredictable turns and their effects, unforeseen impacts or disturbances; and the risks in social planning are accentuated if attempts are made to accelerate it, as in an emergency, without due regard for the time-factor.

None the less, the first duty of an intelligent society in this age is to seek out the causes of things. The scientific method is nowhere needed so much as in the sorting-out of causes and the recognition of the action of the forces supposed to be at the root of our troubles; the first step, however, must be the scientific study of the field of science itself and the conscious planning of policy and research with regard to the social needs of the period and the social functions of science. We cannot be sure that more scientific knowledge will resolve the conflicts between classes, reduce the arrogance of nationalism and diminish the chances of war, but we can at least hope that it will assist in providing a more even-tempered attitude and greater readiness to accept findings even when they involve the disturbance of sectional interests.

Social forms, as Dr. Bowman reminds us, cannot keep pace with creative thought. A time lag is inevitable, because we have found no way to teach and test ideas except through time-consuming and often inconclusive experience, and no one branch of study can solve the whole array of problems of a people. Much more could be done, however, by combined effort on the lines of the team-work which in industrial problems, for example, has yielded brilliant results through the efforts of workers in different branches of physical science concentrated on a single objective. The realization by an increasing number of scientific workers to-day that social action is imperative if freedom of thought and investigation are to be preserved for science itself already provides a stimulus. This consciousness is gradually overcoming the reluctance of those who fear the introduction from politics of bias or prejudice, for the pace at which events move demonstrates that even inaction has political consequences.

The formation of the new Division for the Social and International Relations of Science is one of the most significant recent expressions of this urge to advance science beyond the mere study of Nature at the level of inanimate Nature to the level of men in their group activity. Dr. Bowman's address attempts no positive and final answers as to the solutions of many of the problems thus opened up before us, but his presentation of man's endless adventure in progress reminds us that science is our greatest inspirer of hope. Even in these sombre days of anxiety, it holds out the rational hope that the triumphant methods that have given us deeper understanding and increased efficiency as biological and social mechanisms, will one day give us a still deeper insight into the nature of man and what he may become under rational control.

What gives special pertinence to Dr. Bowman's insistence on this element of pioneering and invention is the change in the nature or emphasis of scientific method. Just when concern with the impact of science on society and with the effect of society on science itself is growing within the ranks of science, scientific workers are coming to realize that there are limits to the extent to which the scientific method of isolation in experiment can be even approximately used. The widening front of science synchronizes, as Prof. H. Levy has pointed out, with the necessity for a drastic change in scientific method itself. It is not merely in social science that the experimenter must become an integral part of the process itself.

The wider view of scientific method, which recognizes the limits within which even a statistical validity can be given to simple repetition, and admits that every scientific experiment is a piece of scientific history and therefore a piece of social history, compels us also to recognize the inter-relation of all phenomena and to see the role taken by each element in relation to every other. In scientific work, failure to appreciate

fully dialectical change may have comparatively slight consequences; the social repercussions of failure to appreciate the dialectical changes produced by and on science in its interaction with society may be almost catastrophic.

Because we do not in general take a scientific view of the processes of change that are manifested in society, and because men of science themselves fail to see that the scientific method requires qualitative transformation before it can be applied to the active handling of those issues, we tend to become mere passive onlookers in a course of events which it should be the first scientific duty of all men to control as they ultimately would control any laboratory process.

The address prepared by Dr. Bowman appeals to the characteristic scientific spirit, which cannot rest with unexplored fields before it. The realm of social action itself is the new laboratory, and the steps towards the control of social processes—the taking of political action and the making of social history—are, first an understanding of the interplay of cause and effect in the sense of the new statistical and dialectical method, and then a decision on the new processes which are to be brought into play to transform the situation qualitatively. In this new and wider field, science will yet forge new and appropriate techniques and wield them as effectively as in the physical domain itself.

FISH MOVEMENTS AND FISHPASSES

La mécanique du poisson de rivière

Qualités nautiques du poisson; ses méthodes locomotrices, ses capacités; ses limites; résistances du fluide; effet de la vitesse, de la pente; résistance de seuil. Par G. Denil. Pp. 395. (Bruxelles: Goemaere, Imprimeur du Roi, 1938.) n.p.

SOME thirty-two years ago, G. Denil, at that time chief engineer of Belgian Public Works, stood by a new weir, 3·5 m. in height, and lacking a fishpass of any kind whatever. As he watched the tail water of the dam, he was struck by the frantic and necessarily unsuccessful efforts of many salmon to surpass this obstacle by leaps, and also their wholesale destruction following exhaustion, by their overcrowding in a restricted channel, and at the hands of fishermen who had no difficulty in capturing their helpless prey.

On thinking over the complex problems which were involved, Denil resolved to seek a full understanding of the conditions necessary for the protection of migratory fishes, and to construct fishpasses so economically that they might become integral parts of all weirs which interrupt the upstream passage of the migrants. So early as 1909 he was able to describe in a long and exhaustive paper his first new successful fishpass, based on the principle that the obstacles involved are oblique to the main waterflow and are spaced so closely that, instead of creating alternate pools and waterjets, they derive secondary streams from the main flow, so that the abrupt re-entrance of these streams causes an energy dissipation of considerable intensity.

Subsequent to the publication mentioned above Denil constructed and controlled a number of fishpasses of exactly the same type and proceeded to improve his system, keeping always in mind the combination of theoretical considerations and of laboratory experiments with observations of the successful control of the passes already in operation. Until 1936 he published very little on the subject of his work. In that year he began a long series of articles published in the *Annales des Travaux Publiques de Belgique*. These articles are brought together in the present book, the title of which, though long, still gives an inadequate indication of the contents.

The first chapter relates to structural features of salmon-like and elongated white fish. The second contains an analysis, depending to a large extent on the basic work of Breder, of their various types of locomotion; swimming against the stream; jumping; and driving with the stream being particularly considered. In the third chapter, the eel and its locomotion are discussed, comparisons being made with matters already considered and also with the sea lampreys. In the fourth chapter, the author describes his own experiments on the velocity-resistance of fish-like bodies. In his fifth chapter, he reports on his own measurements and on those of Kreitman and others regarding the greatest *relative* velocity of fish swimming against a stream, that is, on the 'limit of swimming velocity'. He adds, however, that to attribute *direct* and decisive importance to this limit, is to accept by implication the hypothesis —never previously stated explicitly, but certainly not questioned either—that the swimming ability

is adequately defined by the relative velocity V, or, that the longitudinal component of the weight G of a fish is, in so far as its locomotive effort is concerned, neutralized by the corresponding component of its buoyancy. The three succeeding chapters are devoted to the difficult task of disproving this hypothesis and to proving that the actual locomotory effort or force F_1 is equal to the velocity-resistance plus the resistance directly due to the slope, and

$$F_1 = Z\frac{V^2 F}{2g} + G \sin \alpha, \text{ where } \alpha \text{ is angle of slope.}$$

It would lead far afield to review in detail the author's experimental and theoretical arguments in support of his surprising thesis. Suffice it to state that his evidence, though challengeable on several points, appears on the whole to be fairly convincing. In any event, even the most doubting critic would have to admit that the thesis deserves thorough and systematic study*. Until this has been done, the thesis as a whole must be accepted as a 'working hypothesis' in the practical tasks of fishpass design and in preference to the older one. These three chapters offer particularly stimulating reading, because a number of very different problems of hydraulics and geophysics relating to a steep water surface are employed in analogy.

In the ninth chapter the author turns from discussing a fish as a 'body' in the purely mechanical sense of the word to considering a fish as a living creature. He analyses questions both of the biology and the psychology of fish migration, showing that different species have marked differences in the conditions and 'motives' for their migratory efforts. This chapter will be of much interest to ichthyologists. Some of the views which it expresses may also lead to useful discussions.

Following these preparatory chapters, the author tackles the main problem around which his work is centred, namely, the quantitative study of the mechanical force or locomotory effort, F_1, of which a fish is capable when swimming continuously for a period of about one minute. It is obvious that if one knows the total resistance which a fish encounters in some particular steep channel, and that if one notes which fish pass the channel without difficulty, which pass after a struggle, and which entirely fail to pass, the full data required for the determination of the limiting value of F_1 are known. This is exactly what Denil does in Chapters x and xi. In addition, he makes some less exact but still fairly reliable inquiries into the limiting force F_2 which a fish is able to develop over a very short distance (for example, in jumping, or in facing a local pitch-velocity). The result of these inquiries is to show that the limiting value of F_1 varies between $0{\cdot}5\ G$ and $0{\cdot}7\ G$; that of F_2 varies between G and $1{\cdot}4\ G$. These latter results may be compared with those of Houssey; and although the agreement proves to be very rough, it is nevertheless remarkable, not only in view of the difficulty of the question and the complete independence of their work, but also by reason of the fundamental difference in the mode of approach of these two investigators.

These two chapters are probably the most important in the book because the author, having inquired into the limiting force F_1 for fishpasses constructed by himself according to his old but now imporved principle of energy-dissipation, now gives a short account of these newer designs. Their distinctive feature, as compared with his earlier models, is that both the normal cross-section of the channel and the 'obstacles' are so shaped that the pressure losses of the secondary streams, both at their beginnings and along the secondary channels, are reduced as much as possible so that *vigorous* secondary streams, at their re-entrance, dissipate the energy of the main stream. It is regrettable that only summary information is given by the author on his theoretical ideas and on the very extensive experimental studies on which his designs are now based. In these chapters also the question of arranging the downstream end of a pass is touched upon, and an original contribution is made towards the solution of this difficult matter.

Chapter xii discusses the reduction of slope necessary if the single 'flight' of a steep fishpass between two resting pools is of greater length than that which may normally correspond to a one minute passage.

Chapters xiii and xiv are concerned with the difficult task of offering a rational theory for the choice of dimensions for the ordinary pool-and-jet fishpasses in accordance with the rules laid down in Chapters x–xii for Denil and similar fishpasses. The basis of this theory, which is the computation of the resistance encountered by a fish when it passes through an orifice, is fundamentally at variance with the usual assumptions, the variance being analogous to that concerning fish resistance in steep channels.

The penultimate chapter contains original suggestions for the design of fishpasses. On one hand, an improved form is proposed for the pool-submerged orifice pass, in which the orifice is replaced by a converging tube. Here the author makes one of his interesting excursions into another field of hydraulic engineering, and gives his ideas on some of the important aspects of the

* A preliminary experimental contribution to this detailed study by the reviewer and Dr. C. M. White, of the Imperial College of Science, has led to results decidedly in favour of Denil's formula. A joint publication is being prepared for the *Journal of the Institution of Civil Engineers, London*.

problem of turbulence. On the other hand, he indicates how the Denil principle of energy-dissipation may be adapted to the needs of open channels of very variable depth as well as to closed conduits of rectangular cross-section, and as to how the ordinary Denil channels may be combined with these special conduits in the construction of fishpasses with marked headwater fluctuations. Most of the original and clearly well considered suggestions given in this rather long chapter have not yet been put to the practical test; some of them have not yet been studied under laboratory conditions.

The final chapter deals with the unscientific use, or rather abuse, of the Denil principle of energy-dissipation and with the total failures which naturally result from this cause.

To sum up the contents of this book, the author contributes to the following distinct, though overlapping fields of work: (1) fish biology (mainly mechanics, physiology and psychology of fish migration); (2) practical fish protection (mainly fishpass design); (3) hydraulic engineering in general; (4) fluid mechanics.

I consider Denil's contributions of the greatest importance to fishpass design and to hydraulic engineering in general, and this mainly because of the great value of the Denil principle of energy-dissipation for the economy of fishpasses and probably of some other hydraulic structures such as timber-floating channels, spillways, ship canals and perhaps surge tanks as well. Because of the value—partly actual, partly potential—of the author's fishpass designs, it is regrettable that many of his illustrations regarding these designs are difficult to understand. A few are quite unintelligible or are ambiguous. It is to be hoped that an English translation, which will be awaited anxiously by investigators in widely different fields, will not only be devoid of this minor and disconcerting fault, but will also provide more of the wealth of material from laboratory experiments and velocity measurements for actual fishpasses which Denil has made during his exceptionally thorough investigations.

Even so, the present book, valuable as it is for the number of well-supported experimental results it contains, will be still more valuable for its suggestions of problems to be followed by independent investigators in different fields of work. In particular, research in the field of fluid mechanics will have to concern itself with two important problems raised in Denil's book. These are the deeper physical cause of the extremely efficient energy dissipation given by the Denil system, and the resistance problem of swimming bodies in channels of very varied type.

PAUL NEMENYI.

THE CULTURAL HISTORY OF MANKIND

A History of orld Civilization
By Prof. James Edgar Swain. Pp. xix+615. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 15*s*.

IN six hundred and fifteen pages the author of this book surveys the whole cultural history of mankind, tracing the development of politics, art, religion, science, literature, economics and social life through the ages. Broadly speaking, his classification of topics under periods is—prehistoric and early empires, classical civilization, taking in, in addition to Greece and Rome, early India, China and Central and South America, the Middle Ages, the development of national cultures, and subsequent history down to the close of the War of 1914-18 and "Beginning of an International Culture". In the survey of each section the story of the course of events under each topic is followed by an evaluation of the contribution of the period or people under review to progress.

It is very doubtful whether a survey of this ambitious scope, even of the most elementary character, can be undertaken at the present time by any but a syndicate of experts. Prof. Swain is not unconscious of the difficulty; but his equipment for the task he has so boldly undertaken is open to question. Much of his work reads like notes for lectures to students, who may be expected or required to supplement them by more extended study. For the reading public the treatment is too factual and, notwithstanding the evaluating summaries, too little concerned with the broader aspects of trends and movements in development. This, however, is a matter of method and treatment on which opinion may differ; but in other respects, the book shows serious defects. Apart from errors of fact, which are too numerous, statements are made which, when not categorically erroneous, are gravely misleading.

These defects are especially apparent in the early sections of the book, which deal with prehistory and protohistory down to the close of the 'classical' section. The table of prehistoric civilizations is ludicrously inadequate, as well as inaccurate, omitting mesolithic entirely; while owing to the

treatment of protohistoric civilizations—"ancient empires"—in water-tight compartments on a topographical basis, the whole implication of modern research is missed.

The author would appear here to have used sources which either are out of date and now need supplement and correction, or to have no first-hand acquaintance with the material. He is twelve or fourteen years behind current knowledge. The important archæological discoveries of the prehistoric civilizations of India and China, and the later work in Sumeria of Sir Leonard Woolley (whose name is misspelled), with their influence on outlook and study of the development of the respective cultures are ignored. In another field the same neglect of recent development is shown when in the account of the British constitution the term 'colonies' is still used, and the constitutional relations of Britain and other constituent members of the British Commonwealth of Nations are described in terms which ceased to be applicable after the passing of the Statute of Westminster.

Prof. Swain does not seem invariably to be too well acquainted with the authorities he cites. He refers to the single volume edition of "The Golden Bough" as entitled "Leaves from the Golden Bough" and as "selected by Mrs. Frazer".

THEORIES OF HEARING

Hearing

Its Psychology and Physiology. By Dr. Stanley Smith Stevens and Dr. Hallowell Davis. Pp. xv+489. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1938.) 22*s*. 6*d*. net.

IN spite of all the work which has been done on the ear, it is common knowledge that we still do not know precisely how the ear works. When Weaver and Bray first announced their discovery of the electrical potentials produced by the ear, it looked as if the resonance theory of Helmholtz would have to be finally abandoned. It was found, however, that an incorrect interpretation had been placed on these researches, so that to-day there are probably more believers in the resonance theory than ever before.

It is particularly interesting, therefore, to read this book by Stevens and Davis, since they do not believe in the resonance theory, but in a travelling bulge theory. Now there is nothing particularly new in travelling bulge theories, for they have been proposed from time to time by several experimenters. The evidence put forward by Stevens and Davis is the work of Békésy, who made large-scale physical models, measured the velocity of transmission of the bulge in them, and applied the data thus obtained to the human ear. He also did experiments in which a click and a steady tone are presented simultaneously to the ear.

Now, so far as evidence of models is concerned, a large number have been made. Some of them demonstrated strictly localized vibrations, such as one would expect to find according to the resonance theory of hearing; others, such as those made by Ewald, showed the development of a number of affected regions for single pure tones, thus suggesting the sound pattern theory. Békésy's models, on the other hand, demonstrated a travelling bulge. It seems to me that until we know more about the physical properties of the cochlea, and the physical properties of these models, we are really not justified in drawing any conclusion from them at all, except that the makers of the models are extremely ingenious. With regard to the evidence provided by the click and steady tone presented simultaneously, the experiments should be repeated and varied in different ways before they can be held to refute categorically any theory.

With regard to the book itself, much may be said in its favour. It states in a precise but easily understood way a large number of the facts which are at present known concerning the ear. Specially good are Chapters vii and viii on combination tones, masking, etc. Practically all the figures are well illustrated, the only unsatisfactory ones being such photomicrographs as Figs. 113, 132 and 134. Fig. 113 is particularly misleading. It shows Reissner's membrane very bent, the tectorial membrane displaced upwards away from the hair cells, and the basilar membrane seriously kinked with distorted arches of Corti attached to it. Now that histological technique can produce sections of the cochlea which show none of these defects, one of these sections should be used as a basis for this illustration in future editions of this book. This is a matter of detail only. The book as a whole is excellent and is strongly recommended to all those whose interests lie in the border line between physiology and physics.

H. HARTRIDGE.

INTERPRETATION OF PLANT STRUCTURE*

By Prof. D. Thoday
University College, Bangor

Structure and Function

UNDER the influence of Darwin's concept of 'survival of the fittest', a tendency to assume all structural features to be adaptive was strengthened. It is, of course, essential that the structure of plant organs should enable them to carry out their functions adequately; but perfect adaptation of tissues to their functions would be difficult to define.

The study of xerophytes provides an instructive example.

Before the physiological adaptation of plants to their environments can be properly assessed, we need far more exact knowledge regarding the quantitative relations of their different functions to the environmental factors, and regarding the balancing of those functions.

The question to be answered is not how an organ is adapted to its function, but rather *how its form and structure affect its functioning*.

Quantitative investigation of the effects of minute structural features is often beset with great difficulty. We have not even yet reached finality in the solution of problems presented by stomatal diffusion, as affected by wind and other external conditions and by the size and proximity of the stomatal pores, although much intensive work has advanced our knowledge considerably; nor do we know just how much effect to attribute to the sinking or raising of stomata, or other special devices.

While the exact laws of the diffusion of gases through stomata are difficult to establish, it might be thought that the *distribution* of stomata at least would lend itself readily to adaptational interpretation. Actually, the facts point very largely in the reverse direction. Salisbury's statistical studies in particular have shown that, on the whole, plants in more exposed places have a higher stomatal frequency, and that for a given species the proportion of stomata to epidermal cells is more constant over a range of moisture conditions than stomatal frequency, variations in which are to be interpreted largely as the consequence of different degrees of expansion subsequent to the initiation of the stomata.

This turns the attention away from adaptation to the process of development. Salisbury's results indicate that stomatal frequency is determined by factors at work in two phases of leaf development. The first is the formative phase in which the position and number of stomata are determined in relation to the epidermal cells, mainly by internal influences depending on the hereditary make-up of the plant. The second is the expansion phase, in which the degree of separation of the stomata, already initiated, is determined.

Goebel has shown how problems of development may be attacked inductively in his "Gesetzmässigkeiten im Blattaufbau". The general result of his studies of leaf development was to bring out the repetitive nature of the patterns that are laid down, the units of a pattern showing, at the time of initiation, remarkable constancy of scale. Thus at the growing edge of a fern frond bifurcation of the veins keeps their spacing within certain limits, just as the size of cells in meristems tends to remain more or less constant owing to division when an upper limit is reached. The uniformity of size of the meshes in a net-veined leaf is a similar phenomenon which has been studied by Schuster. Stomata and also root-hair initial-cells show an approximation to uniformity of spacing at their initiation, however much the fact may afterwards be obscured by expansion of cells between the initials, or inhibition of their further development. Küster has emphasized the correlational aspect of such regularities, as depending upon mutual relations between the different tissues or structural elements that make up the pattern.

Another example of a quantitative approach to problems of adaptation is afforded by attempts to correlate the dimensions of parts served and tissues serving them. It is obvious that as the foliage of a tree increases in extent the amount of conducting tissue in the stem increases too; and that from the small twig through branches to the main trunk the amount increases parallel with the increasing number of leaves to be supplied. Jaccard directed attention to the quantitative aspect of this relation; and his pupil Rübel examined it in greater detail for the herbaceous plant, *Helianthus annuus*. Salisbury had already correlated the vascular structure of petioles with the dimensions of the leaf blades, with special reference to the xylem and transpiration.

The correlations displayed were not exact and showed considerable variations. Yet they are remarkable enough, and specially worthy of note when we begin to inquire how such correlations come about. An interaction between one part and another is implied. This aspect has been investigated both experimentally and by anatomical analysis.

* From the presidential address to Section K (Botany) of the British Association, delivered at Dundee on September 1.

Jost's classical experiments on Phaseolus seedlings (1893) showed that severance of leaf-trace bundles in the middle of an internode interrupted their development below the point of severance, but not above it, although neither part could function normally.

In herbaceous plants, cambial activity at any given level often exhibits local variations which are related to active development of different leaves above. In the sunflower this is conspicuously shown.

That the developing organs actually influence the growth of the stem below them, to considerable distances, is a natural inference.

Strong support for the reality of such influences has been forthcoming from one of the most spectacular advances in knowledge in recent years – the discovery of chemical agents controlling growth, which was an outcome of investigations on the curvature of shoots in response to light. The growth-promoting substances, called auxins, are highly active. One fifty-millionth of a milligram produces a measurable effect on the oat coleoptile. They are produced especially by actively growing parts of shoots—sprouting buds, shoot-tips and young expanding leaves. They not only influence growth in length, but also produce other effects which are of greater interest in the present connexion.

It has been shown experimentally by Snow and confirmed by others that auxin stimulates cambial activity. Söding has actually detected auxin in the cambium of trees in spring and summer. He states that it appears there a little in advance of the resumption of cambial activity in the spring. Since it is produced by developing buds and young leaves and travels downwards, the downward spread of cambial activity from the base of the awakening buds in spring is thus accounted for in terms of an effect of auxin which is experimentally demonstrable. The basipetal conduction combined with tangential localization exhibited in this instance gives strong support to the interpretation, already suggested, of the localized cambial activity in the intact sunflower stem, as indicating a causal influence proceeding downwards from the actively growing leaves.

Evidence has also been adduced of stimulating agents of a chemical nature liberated from wounded tissues.

The demonstration that such hormones exist and are effective in influencing plant development is of far-reaching significance. It is a challenge to students of plant structure to view their data dynamically. The statement that one part of a plant influences another is no longer to be understood merely as a convenient way of expressing a correlation, in a figurative sense, but is a legitimate hypothesis in a causal sense.

THE PHYLETIC OUTLOOK

The evolution theory gave a new meaning to natural relationships, as revealed by the systematist, and a new aim to the systematist himself. Previously a natural system was conceived as a system of classification depending on the balance of similarities, estimated from a consideration of all the characters of the species, as compared with an artificial system depending on particular characters selected for their convenience. The ancestry of species now became, in theory, the main basis for a natural classification.

It was soon realized that, as similarities in some features are often accompanied by dissimilarities in others, similarity might not always signify relationship. Fossils themselves, moreover, provided clear evidence that similar organs or structures have been evolved independently along different lines, by different phyla, so that the possession of seeds, for example, is not evidence of common ancestry for all seed-bearing plants.

Modern genetics reveals, as the most prolific cause of variation, irregularities in the process of nuclear division and the behaviour of the chromosomes, and changes in the substance or structure of the chromosomes, which appear to be entirely erratic and haphazard.

If, however, we turn from the minor variations which differentiate species and horticultural varieties and survey the major events that have marked the evolution of plants, it is difficult to regard these as haphazard. Besides seeds, already mentioned, a number of features are found with even wider distribution, common to groups which cannot be traced to a common origin. Such are the alternation of sexual and asexual generations; archegonia; the formation of spores in tetrads, following a reduction division; air-space systems and stomata; vascular tissues; then fertilization, evolved also in the animal kingdom, and the cell as the unit of construction; the nucleus with its chromosomes and their highly organized behaviour in division. The enumeration need not come to an end on the plane of cellular, structural organization, for chemical parallels are quite as remarkable. Consider, for example, the similar enzymes and enzyme complexes responsible for carbohydrate metabolism in yeast, in the higher plant and in animal muscle; the hæmins found in plant and animal cells alike, and the related substances, chlorophyll in the green plant and hæmoglobin in animal blood, with uniquely important functions. Finally, there are the proteins and other important basal constituents of living matter.

The idea was suggested by F. F. Blackman in 1921, in reference to Nef's work on the inter-

changeability of carbohydrates, that the biologically important carbohydrates are just those which are chemically most likely to arise—most readily formed, most stable, etc. May we not extend this idea to explain the universality of particular chemical compounds or radicals—like the amino-acids, limited in number, found in protoplasm?

The conditions for an epoch-making event like the arrival of chlorophyll were provided by the previous course of chemical evolution, in common characters of living matter, and by particular variants of them under particular conditions, which may have occurred but rarely in combination, but are scarcely to be envisaged as unique.

If it is legitimate to regard chemical events in this way, as occurring with a frequency concordant with their inherent probability, may we not carry this idea on to the higher plane of cellular organization and structure? To do so is to direct attention to the nature of that stability and developmental harmony which are so conspicuous a feature of living organisms; for persistence and occurrence become more and more determined and limited by the pre-existing system through which evolution works. Natural selection of harmonious changes may have been more important than elimination of functionally unfit mature organisms. It is developmental harmony which is important, of which functional efficiency of adult organs is but a part.

We are thus once again led to the consideration of development. If we can obtain light on the laws of harmonious development, we may be in a better position to understand the nature of those major changes which the great pageant of evolution unfolds.

Seedling Structure

As an example of the application of causal principles to old problems, I propose to consider the structure of seedlings.

The broad survey achieved by British workers revealed large differences within closely related groups, which made it more difficult to interpret resemblances as of phylogenetic significance. A high degree of correlation was observed, on one hand, between slender smallness of seedlings and diarch root structure, with two xylem poles extending right up the hypocotyl; and, on other hand, between large diameter and tetrach or polyarch structure, with stem-like pattern in the hypocotyl. Both Compton and T. G. Hill and de Fraine emphasized seed size as an important factor influencing seedling structure.

Another factor of a similar kind was the influence of the plumule, the traces from which, when precociously developed, shared with the cotyledon traces in the early structure of the hypocotyl. In certain cases, particularly among the Amentiferæ, the traces from the plumular leaves were found to be triads like those from the cotyledons (Davey, 1916), and these with their central xylem strand extend above the cotyledonary node into the epicotylar stem itself. Phylogenists were inclined to interpret this as a more extensive persistence of primitive structure in a relatively primitive group. But the occurrence of a root-like solid core of xylem in the epicotyl of the Vicieæ, an advanced group among the Leguminosæ, scarcely harmonizes with phyletic ideas, as Compton pointed out, and makes phylogenetic interpretations appear less certain.

Bugnon tried to approach the facts objectively, without phyletic aim or preconceptions, from the developmental point of view. As has been recognized since the work of Sanio, the differentiation of the leaf-trace bundles progresses basipetally from the node. Bugnon observed that in *Mercurialis annua*, as in many other plants, they normally fork into two, so avoiding incoming bundles immediately below, before uniting with other bundles lower down. The cotyledon traces likewise fork, though they do this sooner and in relation to the vascular system of the root.

Turning to the radicle, Bugnon notes that the root structure is quite typical. All other roots, however, arise from organs already differentiated. They form their own characteristic pattern of vascular arrangement, and this is linked by commissural elements to the appropriate tissues already present in the parent organ. In the case of the radicle, an exactly similar root apparatus has to be linked up, not with tissues fully differentiated, but with tissues still in a meristematic condition. The connecting tissues are therefore similar to ordinary conducting strands, not special commissural elements.

Bugnon did not, so far as I am aware, attempt to extend the same principles of interpretation to the wider range of facts which have been brought to light, and it appears worth while to see how far this can be done.

In the first place, from a causal point of view, certain principles may be regarded as established. The first is the power of self-determination inherent in growing organs and especially in apical growing points—each developing a characteristic pattern of external form and internal structure. The second is the influence of apical developing organs on the structure of other parts still capable of growth—this applying particularly in the basipetal direction and therefore mainly to the influence of the shoot apex and young leaves on the parts below them.

With regard to the root, a spectacular demonstration of its power of self-determination has been

provided by Philip R. White who, following on the pioneer work of Robbins and Maneval, succeeded in 1934 in proving that root-tips cut from the plant can be grown continuously for years in a nutrient solution containing the essential salts, sugar, and a small concentration of an extract of yeast.

In the large adventitious roots of many Monocotyledons, it is particularly evident that no relation exists between the pattern laid down in the root primordium and that already present in the stem to which it has to be connected. The repetitive nature of the pattern and its inherent stability also become more obvious. The alternation of exarch xylem strands with phloem strands, in a ribbon with definite radial polarity, expresses a harmonious balance of influences and developmental processes. The fundamental uniformity of the root pattern throughout the great majority of vascular plants is further evidence of this inherent stability.

To turn to the shoot: it will probably be admitted that the shoot apex is a self-determining and dominant centre of development. It controls the polarity of the shoot, and round it the repetitive pattern of leaf primordia unfolds. The apical bud as a whole controls also primary development and secondary growth in the stem below. There is much in the system of relations exhibited which is reminiscent of the part played by organizers in the development of animal embryos.

In the determination of primary structure in the stem the leaf primordia play a predominant part. The number of vascular strands in the leaf base depends partly on hereditary factors, but partly on size. This is particularly clear in Monocotyledons, where the bundles arise in succession, separated by parenchyma, as the new leaf primordium extends round the apex.

Now, in seedlings the conditions are unique. At two ends of a short meristematic axis are two self-determining centres of different kinds in close proximity, two opposite poles, a shoot pole and a root pole, each of which is capable of impressing its own inherent pattern on the meristematic tissues to which it gives rise. Under these conditions we cannot assume that the spheres of influence of each will be sharply defined, or that they will necessarily be fixed. If the influence of the poles depends on hormones emanating from them, the boundary might well change with changes in relative vigour of the two organizing centres, and differ also from one species to another.

It appears reasonable, therefore, as a working hypothesis to interpret the structure of seedlings in the following way:

(1) The cotyledons and, if the plumule is precocious, the plumular primordia, influence the number of procambial strands in the hypocotyl and its diameter growth at an early formative stage. The form of the cotyledons plays a part. Nutritive and other factors afterwards affect the expansion of the hypocotyl and the degree of separation of the bundles by parenchyma.

(2) Differentiation within the strands of procambium is controlled initially by the root apex in the majority of cases, but to a variable distance upwards. The triad represents the smallest unit of the root pattern, existing as a detached arc, whether in the hypocotyl or a dorsiventral cotyledon.

(3) In the upper part of the seedling, sometimes only in the blade of the cotyledon, sometimes also in the petiole, or even lower, the shoot itself holds sway, and in place of a triad is found a single bundle. The intervening region is one of compromise and accommodation between the two patterns.

(4) With increasing activity of the shoot, further development is stimulated, from above downward, in the formation of centrifugal xylem on the inside of the phloem strands. These appear to be the main channels of the basipetal influence. In Dicotyledons the centrifugal xylem is commonly if not generally the result of cambial activity, which ultimately extends down into the root itself.

One factor in the determination of the relative preponderance of root and shoot is very probably the production of auxin by cotyledons and plumule.

We have seen how a substance of known composition, auxin, acts as an agent in the co-ordination of different parts of a plant, but this does not mean that we can explain the activities that are co-ordinated. Great as have been the advances in biochemistry, we are not yet furnished with the means of expressing in physico-chemical terms the delicacy and subtlety of the adjustments exhibited even in plants.

Take, for example, the adhesive disk and haustorium of a mistletoe seedling. This remarkable organ is the result of a series of co-ordinated responses in the growth of the little green meristematic knob from which it arises. Contact pressure leads to one-sided growth, by which it brings itself face downward on to the surface, to which it adheres with the aid of a special viscous material. There follows further growth of its now dome-shaped outer shell, the edge of which moves slowly outwards as the area of attachment widens. Under the dome, cells of the lower surface grow out as papillæ, which adhere closely to the epidermis or cork of the host twig. By the outward and upward movement of the growing shell and a contraction of tissue within it, the papillæ are lifted sideways and the adhering outer protective layer is torn up. Then new papillæ fasten themselves to the next cork layer and the tearing process is repeated. In this way several such layers may be picked up until

a breach is made in the periderm, giving access to the living tissues within. Through this slit the wedge-shaped haustorium grows.

It is strikingly obvious in a specialized organ such as this, where growth is closely and uniquely adjusted in response to a particular environment and in relation to a peculiar, special mode of life, that structure and behaviour are interdependent. There is, however, no logical justification for neglecting to interpret the development of ordinary plant organs on similar lines. The main difference is that the cells respond chiefly to internal influences, though the organ as a whole exhibits tropic curvatures in response to appropriate external stimuli.

It is not possible to pursue this line of thought further; but reference should be made to the work that has already been done by Schüepp, Priestley, Adriance Foster, Helm, Grégoire, Snow, the veteran Schoute, and many others towards the elucidation in detail of the course of differentiation in the shoot of Dicotyledons and Monocotyledons, from which are gradually emerging a better understanding of the principles of their developmental organization.

NUCLEAR REACTIONS IN STELLAR EVOLUTION

By Prof. G. Gamow,

George Washington University, Washington, D.C.

(1). THE question of the sources of energy of stars, and the closely connected question of stellar evolution, have presented for a long time the most important unsolved problem of theoretical astrophysics. The first step towards the understanding of the physical processes leading to the tremendous energy liberation which is responsible for the observed radiation of stars was made about ten years ago. It was shown[1], on the basis of the quantum theory of nuclear transformations, that, at the very high temperatures existing in the interior of stars, the ordinary thermal collisions between the particles possess sufficient energy to produce artificial nuclear transformations. It was also shown that the energy liberation in such *thermo-nuclear reactions* is sufficiently high to explain the radiation of stars only in the case of collisions between the protons and the nuclei of light elements (up to about atomic number 10). It took, however, ten more years before our knowledge concerning nuclear reactions developed to such an extent that it became possible to choose particular nuclear reactions as responsible for the energy-production in different cases and to give on this basis a clear and consistent picture of stellar evolution. The exact formula for the energy production of a thermo-nuclear reaction (per gram per second) can be written in the form[2]:

$$\varepsilon = \frac{4}{3^{5/2}} \rho X_1 X_2 \frac{\hbar \Gamma r_0^3 Q}{m_1 m_2 m e^2 Z_1 Z_2} \exp.^{4} \left(\frac{2 v_0 m e^2 Z_1 Z_2}{\hbar^2} \right)^{1/2} \cdot \tau^2 e^{-\tau} \quad (1)$$

Here ρ is the density of the gas, X_1 and X_2 the concentrations (by weight) of the two reacting types of nuclei, m_1 and m_2 their masses ($m = m_1 m_2/(m_1 + m_2)$), $Z_1 e$ and $Z_2 e$ their electric charges, r_0 the combined radius, Q the energy production per reaction, and $\Gamma/\hbar$ the probability of reaction after the penetration through the potential barrier. The dependence upon temperature is given through τ, which is defined by:

$$\tau = 3 \left(\frac{\pi^2 m e^4 Z_1^2 Z_2^2}{2 \hbar^2 k T} \right)^{1/3}, \quad . \quad . \quad . \quad (2)$$

T being the absolute temperature of the gas and k the Boltzmann constant.

This formula was used[3] in choosing the nuclear reaction responsible for the energy liberation of the sun. The complete list of all possible reactions between the protons and different light nuclei is given in the accompanying table, together with the values of Q and Γ:

Reaction	Q (mMU)	Γ (ev.)	$\varepsilon \left(\frac{\text{erg.}}{\text{gm. sec.}} \right)$
$^1H + {}^1H \rightarrow {}^2H + e+$	1·53	Ref. 4	2·2
$^2H + {}^1H \rightarrow {}^3He + h\nu$	5·9	1	$1 \times 10^{+17}$
$^3H + {}^1H \rightarrow {}^4He + h\nu$	21·3	10	$3 \times 10^{+18}$
$^6Li + {}^1H \rightarrow {}^4He + {}^3He$	4·1	5×10^3	$1 \times 10^{+18}$
$^7Li + {}^1H \rightarrow 2{}^4He$	18·6	4×10^4	$5 \times 10^{+18}$
$^9Be + {}^1H \rightarrow {}^6Li + {}^4He$	2·4	10^6	$3 \times 10^{+13}$
$^{10}B + {}^1H \rightarrow {}^{11}C + h\nu$	9·2	10	$3 \times 10^{+8}$
$^{11}B + {}^1H \rightarrow 3{}^4He$	9·4	10^6	$3 \times 10^{+11}$
$^{11}C + {}^1H \rightarrow {}^{12}N + h\nu$	0·4	0·02	1·1
$^{12}C + {}^1H \rightarrow {}^{13}N + h\nu$	2·0	0·6	180
$^{13}C + {}^1H \rightarrow {}^{14}N + h\nu$	8·2	30	$3{\cdot}6 \times 10^{+4}$
$^{14}N + {}^1H \rightarrow {}^{15}O + h\nu$	7·8	5	30
$^{15}N + {}^1H \rightarrow {}^{12}C + {}^4He$	5·2	10^5	$4{\cdot}5 \times 10^{+3}$
$^{16}O + {}^1H \rightarrow {}^{17}F + h\nu$	0·5	0·02	7×10^{-8}
$^{19}F + {}^1H \rightarrow {}^{16}O + {}^4He$	8·8	10^2	55
$^{22}Ne + {}^1H \rightarrow {}^{23}Na + h\nu$	10·7	10	7×10^{-5}
$^{25}Mg + {}^1H \rightarrow {}^{27}Al + h\nu$	8·0	10	8×10^{-8}
$^{28}Si + {}^1H \rightarrow {}^{31}P + h\nu$	7·0	10	3×10^{-23}

The last column gives the calculated energy liberation of different reactions for the conditions

existing in the interior of the sun (that is, $T = 2 \times 10^{7}$° C.; $\rho = 80$ gm./cm.³ and $x_{\text{hydrogen}} = 0{\cdot}35$) with the additional hypothesis that the concentration of the element in question is 0·1 (except, of course, the first reaction, where both X_1 and X_2 are taken to be 0·35).

The observed average energy production of the sun is 2 ergs/gm.sec., which corresponds to an energy production of about 60 ergs/gm.sec. in the central regions. Comparing this value with the numbers in the last column of the table, we see at once that the nuclei ^{2}H, ^{3}H, ^{6}Li, ^{7}Li, ^{9}B, ^{10}B and ^{11}B, if present at all, should have extremely small abundances in the central regions of the sun;

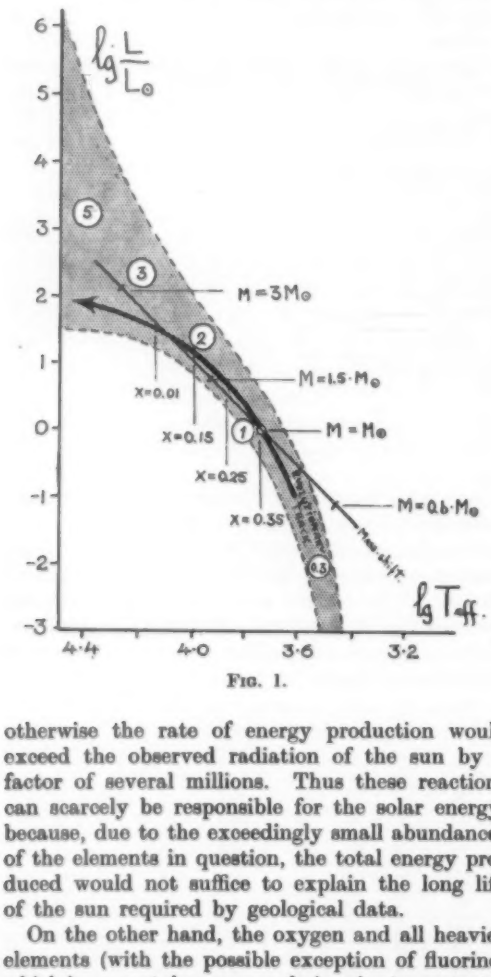

FIG. 1.

otherwise the rate of energy production would exceed the observed radiation of the sun by a factor of several millions. Thus these reactions can scarcely be responsible for the solar energy, because, due to the exceedingly small abundances of the elements in question, the total energy produced would not suffice to explain the long life of the sun required by geological data.

On the other hand, the oxygen and all heavier elements (with the possible exception of fluorine, which is present, however, only in minute amounts) cannot give sufficiently high energy production at solar temperatures.

Moreover, the exact calculations show that β-emitting reaction between two protons also leads to an energy liberation which is about thirty times too low for the sun.

The remaining reactions, of carbon and nitrogen nuclei, seem to be therefore the only possibility. It should be noticed first of all that these reactions possess a very important property, forming a *cyclical* chain in which both elements are permanently regenerated. We have in fact the following sequence:

$$\begin{aligned} {}^{12}C + {}^{1}H &\rightarrow {}^{13}N + h\nu \\ {}^{13}N &\rightarrow {}^{13}C + e^{+} \\ {}^{13}C + {}^{1}H &\rightarrow {}^{14}N + h\nu \\ {}^{14}N + {}^{1}H &\rightarrow {}^{15}O + h\nu \\ {}^{15}O &\rightarrow {}^{15}N + e^{+} \\ {}^{15}N + {}^{1}H &\rightarrow {}^{12}C + {}^{4}He \end{aligned} \qquad (3)$$

We see that in this chain both ^{12}C *and* ^{14}N *nuclei play only the role of catalysts and that the final result of the cycles is the transmutation of hydrogen into helium.*

The rate of the reaction chain is always determined by the rate of its slowest link which is, in our case, the proton capture by ^{14}N. With this rate and the energy liberation of 4×10^{-5} ergs per cycle, one obtains for the rate of energy production the value 100 ergs/gm. sec., in excellent agreement with the actual value.

Thus there seems to be no doubt that *energy production in the sun is due to the carbon-nitrogen reaction cycles*[3].

(2). We can now answer the question concerning the characteristics of stars with the same energy-producing reaction but different masses and chemical constitution, by comparing them with the sun by means of the so-called *homology transformations* of stellar models. There are *nine* different physical quantities defining the external properties and internal structure of a star: the total mass M, the total luminosity L, the radius R (or the effective temperature defined by $T_{\text{eff.}} = \sqrt[4]{\frac{L}{4\pi R^2 \sigma}}$), the average molecular weight μ, the coefficient of opacity of stellar matter $\varkappa_0$, the product of concentrations of two kinds of reacting nuclei X_1X_2 and the functions of ρ, p and T giving the distribution of density, pressure and temperature in the stellar interior. These quantities are connected by *five* fundamental equations: the definition of mass M through ρ and R; the equation of hydrodynamical equilibrium; the gas law; Eddington's equation for the transport of energy; and the formula giving the rate of thermo-nuclear energy production. Thus, choosing for four independent variables the M, μ, $\varkappa_0$ and X_1X_2, we can determine the relative changes of other variables by simple proportionality relations.

It is customary to classify the stars in the frame

of the so-called Hertzsprung–Russell diagram, plotting the logarithms of absolute luminosities against the negative logarithms of effective temperatures.

For these two directly observable quantities we have the following homology transformations[5]:

$$\left(\frac{L^1}{L}\right)=\left(\frac{M^1}{M}\right)^{\frac{4n+13\cdot25}{n+1\cdot75}}\left(\frac{\mu^1}{\mu}\right)^{\frac{5\cdot5n+20\cdot25}{n+1\cdot75}}\left(\frac{\varkappa_0^1}{\varkappa_0}\right)^{-\frac{n+3}{n+1\cdot75}}\left(\frac{X_1^1X_2^1}{X_1X_2}\right)^{-\frac{1\cdot25}{n+1\cdot75}}$$

$$\left(\frac{T_{\text{eff}}^1}{T_{\text{eff}}}\right)=\left(\frac{M}{M}\right)^{\frac{10\cdot5n+4\cdot94}{n+1\cdot75}}\left(\frac{\mu^1}{\mu}\right)^{\frac{0\cdot87n+9}{n+1\cdot75}}\left(\frac{\varkappa_0^1}{\varkappa_0}\right)^{-\frac{0\cdot25n+1\cdot25}{n+1\cdot75}}\left(\frac{X_1^1X_2^1}{X_1X_2}\right)^{-\frac{0\cdot81}{n+1\cdot75}}, \qquad (4ab)$$

where n is the exponent in the temperature dependence of N–C-cycles, which at temperatures around 2×10^{7}° C. is equal to 18.

If we consider stars with the same chemical constitution, the values of L and $T_{\text{eff.}}$ will depend only on M, and this dependence is shown by a straight line in Fig. 1, representing the above-mentioned Hertzsprung–Russell diagram. The numbers along the line correspond to the values of $M/M\odot$. The shaded area represents the so-called *main sequence* in which most of the known stars are located, and the observed masses of stars are indicated by numbers in little circles. The close agreement between the observed and calculated locations brings us to the conclusion that *the main sequence should be interpreted as the collection of stars of different masses with the same chemical constitution and the same energy-producing reaction as in the sun (that is, C–N-cycles).*

Although the agreement between the observed values of M, L and the theoretical relations (4*ab*) with $n=18$ is excellent for the stellar masses between $0\cdot5\ M\odot$ and $2\cdot0\ M\odot$[6], there are quite noticeable deviations at both ends of the main sequence. The deviations for very luminous stars of large mass are, most probably, due to the effect of the high radiative pressure, which has to be neglected in the derivation of the homology transformations. On the other hand, the deviations at small luminosities might be due to the fact that for these stars the C–N-cycle is no longer the main energy-producing reaction. We have seen above that in the sun the $^1H+{}^1H$ reactions give only 1/30 of the total energy production; however, due to its comparatively small temperature dependence, this reaction becomes predominant at temperatures below $1\cdot5\times10^{7}$° C., which just correspond to central temperatures of stars on the lower part of the main sequence.

We can now apply the homology transformations (4*ab*) to the study of evolutionary changes of a star due to the continuous consumption of the hydrogen supply by the energy-producing reaction. The transmutation of hydrogen into helium increases the average molecular weight μ and the opacity $\varkappa_0$ of the stellar substance and decreases the value of X_1X_2 (in which X_1 is now the constant nitrogen content, and X_2 the variable hydrogen content). This defines the changes of the luminosity and the effective temperature and enables one to draw the evolutionary track of the star in the Hertzsprung-Russell diagram. In Fig. 1 such a track for the sun is shown by the heavy line, the numbers along the track representing the hydrogen content at different stages of the evolution. We see that *during the process of the (hydrogen-) evolution the luminosity and the effective temperature of any star, and in particular of our sun, is bound to increase by quite a considerable amount.* But inasmuch as for the sun it would take $1\cdot2\times10^{10}$ years to burn all its present hydrogen content, the yearly changes of the luminosity and spectral class are quite negligible and could not be detected by observation.

Here, however, is an important question. If different stars at different stages of their evolution possess quite different luminosities, there should be no correlation between the luminosities and masses of stars; this is, however, in contradiction with the well-established existence of the empirical mass-luminosity relation. The solution of this difficulty is very simple[7]. The rate of consumption of hydrogen at different stages of the evolution is evidently proportional to the total luminosity of the star. Thus the star will stay a much longer time in the lower part of its evolutionary track and pass much more quickly through the stages of high luminosity. *Thus the empirical mass-luminosity relation should be considered as a statistical regularity due to the fact that most of the stars are observed in the lower part of their evolutionary track.* A more detailed survey of stellar masses must necessarily lead to the detection of stars with luminosities considerably higher than those required by the ordinary mass-luminosity relation. It should be noticed, however, that for the stars in the lower half of the main sequence, such late stages of the hydrogen evolution probably could not be observed at all, because the evolutionary life of these stars is considerably longer than the period of time ($\sim10^{9}$ years) which has passed since their formation.

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(*To be continued*)

OBITUARIES

Dr. A. C. D. Crommelin

WE deeply regret to record the death of Dr. A. C. D. Crommelin which occurred on September 20. Andrew Claude de la Cherois Crommelin was born at Cushenden, Co. Antrim, on February 6, 1865, being the third son of Mr. Nicholas de la Cherois Crommelin, a member of the Huguenot family of that name. Educated at Marlborough College, he afterwards went to Trinity College, Cambridge, where he graduated as twenty-seventh wrangler in the Mathematical Tripos of 1886.

After leaving Cambridge, Crommelin became for a time an assistant master at Lancing College; but his interests lay in astronomy, and it was fortunate for him that in 1891 the appointment of an additional assistant at the Royal Observatory, Greenwich, was sanctioned. Crommelin proved to be the successful candidate and he joined the staff on May 11, 1891. He was given charge of the altazimuth telescope and of the reduction of the observations of the moon which were made with it. He also undertook the reduction of observations of occultations of stars by the moon and of visual observations of the positions of comets made with the Sheepshanks equatorial. This work he continued to do throughout his career at Greenwich, though the programme of work with the altazimuth telescope became more extensive when, a few years after his appointment, the older instrument of Airy was replaced by a larger and more elaborate one.

The character of his work prompted Crommelin to take up the computation of orbits and ephemerides, and his name soon became known as the computer of the orbits of newly discovered comets and minor planets and of ephemerides for them. But his most important contribution to astronomy was the work he did, in collaboration with Cowell, in investigating the motion of Halley's comet and predicting its position on its return in 1910. Their prediction of the date of perihelion passage differed but three days from that actually observed. This research gained for its authors the Lindemann prize offered by the Astronomische Gesellschaft, and the University of Oxford conferred on them the honorary degree of D.Sc.

Crommelin contributed a number of papers of a similar nature to the *Monthly Notices of the Royal Astronomical Society*, and for more than forty years wrote the annual notes on minor planets and comets, a piece of work demanding much care and research on his part. For some years he computed and published ephemerides for the physical observation of Mars, Jupiter, Saturn and the moon, until this work was undertaken by the "Nautical Almanac". In his private capacity he went on several eclipse expeditions, and in 1919 he was chosen to go on the official expedition to Brazil when the results obtained verified the predicted deflection of light by the sun's gravitational field. For very many years he was a valued contributor to NATURE of notes and articles on astronomical subjects.

Crommelin was elected a fellow of the Royal Astronomical Society in 1888. He served as one of its secretaries from 1917 until 1923 and was president during 1929–31. He was president of the British Astronomical Association in 1904–6 and was for many years director of the Comet Section.

Crommelin retired from the Royal Observatory in May 1927, after thirty-six years service, but he continued to be actively interested in the work of his choice. He married, in 1897, Letitia, daughter of the Rev. Robert Noble. Mrs. Crommelin died in 1921, and he lost his elder son and younger daughter in tragic circumstances. He is survived by one son and one daughter.

Commander F. Wild, C.B.E.

COMMANDER FRANK WILD, whose death took place on August 21, was born at Skelton, in Yorkshire, in 1873. His father was clerk of the Eversholt Parochial Charity at Woburn (Beds.) and on his mother's side he claimed descent from the celebrated antarctic pioneer, Captain Cook. He entered the Merchant Service in 1889, receiving his early training in sail in the famous clipper ship *Sobraon*. He entered the Royal Navy in 1900, and was serving as an A.B. in the *Vernon* when he was appointed to the National Antarctic Expedition (1901–4) under Scott. On this expedition, while still serving as a naval rating, he earned the praise and admiration of Scott himself for his coolness and resource under danger and for his qualities of leadership. But even more important for his future career was the attachment which grew up then between him and Shackleton, an attachment which developed into a lifelong friendship.

Wild's subsequent polar career is well known. He returned to the Antarctic with Shackleton in the *Nimrod* in 1907 "in charge of provisions", and took part, along with Shackleton, Adams and Marshall, in that magnificent journey which all but reached the Pole. Almost immediately afterwards he joined the Australasian Antarctic Expedition of 1911–14 under Dr. Douglas Mawson, during which he commanded the Western Base on Queen Mary Land. At the conclusion of this expedition, after a brief interval ashore, he sailed again with Shackleton on the eve of the War of 1914-18 in the ill-fated *Endurance*. After the loss of that vessel in the Weddell Sea, he remained in charge of the expedition on Elephant Island, and there through four and a half months of extreme privation he pulled through to health and safety twenty-one semi-starved and ill-clad men.

After the tragic death of Shackleton at South Georgia in 1922, Wild commanded the Shackleton-Rowett Antarctic Expedition of 1921–22 in the *Quest*. Although the vessel failed to reach her main objective,

the Enderby-Coats Land coast, useful work was accomplished, covering a wide scientific field, notably on the islands of South Georgia, Elephant, Gough, Tristan da Cunha and others.

During the War of 1914–18, Wild led a commercial expedition to Spitsbergen and served in the R.N.V.R. with the rank of Commander. He went to South Africa in 1922 and engaged in farming. The venture failed, and, like so many others who have served a great cause with selfless devotion, he fell upon hard times. He was granted a Civil List pension shortly before his death.

Wild was a little man of slight build. Most indeed would have called him frail until they felt the power of his hands or saw him trimming coal in the intense heat of a ship's bunker in the tropics, or swinging back on a topsail halyard. He had bright, piercing blue eyes which twinkled at you when he spoke. They twinkled most—with sheer pleasure—during the headlong rush and excitement of shortening sail in heavy weather, or when, as he often did, he held the steer-oar of a small boat while negotiating a dangerous landing on a lee shore.

Wild was essentially a seaman of high quality, and a leader of men. His scientific achievement can therefore only be fairly judged by the work of those specialists—the surveyors, geologists, meteorologists, zoologists and others—who were placed in his charge and were encouraged by his example. It is perhaps not generally realized, however, that it was Wild who discovered the coal seams in the great Beacon Sandstone formation high up on the Beardmore Glacier in 85° S. His detailed description of these coal measures is incorporated in the publications of the late Sir T. W. Edgeworth David.

As leader of Mawson's Western Party he was responsible for a notable contribution to antarctic exploration and research when he opened up Queen Mary Land by sledge under conditions which have seldom, if ever, been equalled for severity in the history of polar research.

If there was work to do, however hard or unpleasant the task, Wild never spared himself. His devotion to the cause which he served, his unquenchable spirit under severe trial, his cool head in emergency, his complete selflessness and, above all, his ever ready and kindly advice made him loved and respected by all who served with him throughout his long polar career.

JAMES W. S. MARR.

WE regret to announce the following deaths:

Prof. Sigmund Freud, For. Mem. R.S., formerly professor of neurology in the University of Vienna, on September 23, aged eighty-three years.

Dr. J. A. Loeser, author of "Die psychologische Autonomie des organischen Handelns", in which novel views on animal behaviour were put forward, on September 12, aged forty-one years.

Dr. G. M. Murray, emeritus professor of medicine in the Victoria University of Manchester, known for his work on diseases of the thyroid gland, on September 21.

NEWS AND VIEWS

The British Association in War Time

SINCE the Dundee meeting of the British Association was brought to an untimely end, the office at Burlington House, London, has been re-opened for the routine work which always follows upon the annual meeting, and a certain amount of official business is also being carried on at Down House, where the rooms normally open to the public are closed and dismantled, and Charles Darwin's former dining-room serves the valuable if regrettable purpose of an office-refuge. The first number of the new quarterly report, *The Advancement of Science*, will be produced, all being well, probably rather later than the announced date at the end of October, and in smaller bulk than was contemplated. As to its future, and, for that matter, the future of the Association's work generally, obviously nothing definite can be stated. Preparations for the intended meeting next year in Newcastle-upon-Tyne have been suspended, by agreement with the authorities there. It is an unhappy coincidence that the last meeting in that city was the last to be held during the last war, in 1916. Conditions are so far different now that it is impossible to estimate whether any sort of meeting could or should be held next year, whether in Newcastle or anywhere else. Yet it is permissible to dream of the possibility of adapting the Association's very flexible constitution to a meeting of four days or so, with science in war time as the leading theme, with sessions in three or four telescoped sections—physical, biological, anthropological, and economic, for example—and of course the Division for the Social and Economic Relations of Science. No doubt before anything of this sort could be undertaken there would be need of careful and wide inquiry as to the amount of support which might be forthcoming for such an effort. But if this were favourable, such a meeting could be arranged at relatively short notice. "The minor humours of war" may be offered in advance as one subject on the anthropological side.

The Fourth Partition of Poland

DURING the twenty years of its existence as an independent republic, Poland, like Czechoslovakia, fostered science and learning in a manner which gained the admiration of the whole civilized world. Its President, Prof. Ignacy Mościcki, was a distinguished chemist, and many other men of science took leading roles in the country's affairs and were able to ensure that education, science and culture were not neglected. There were thus very flourishing universities at Warsaw, Cracow, Lwów, Poznań, Vilno and Lublin. Almost every important town had its polytechnic high-school and there were

special colleges and institutes connected with agriculture (Warsaw, Pulawy and Bydgoszcz), mining (Cracow) and veterinary science (Lwów), in addition to various scientific academies and societies in different centres.

IT is doubtful whether these centres of science will function again before the end of hostilities, and even if some attempt were made to utilize them it will not be for Polish science and culture, since the unhappy nation is again witnessing a partition, the fourth, of the State. From what appears to be the intention of Poland's invaders, Germany will gain possession of the seats of learning at Warsaw (the university is in the western half of the city), Cracow, Bydgoszcz and Poznań, whilst those of Lublin and Lwów will pass into Russian hands. The fate of Vilno and its university and cultural institutes is not certain, since the possibility of its return to Lithuania must not be excluded. Our sympathy goes out to the many men of science in Poland whose work has been interrupted and who have to suffer the horrors of a modern war in which they are the victims of unprovoked aggression.

Patents in War Time

VARIOUS Acts of Parliament and statutory rules control the issue of patents. They lay down definite time limits within which certain things must be done by an inventor who is applying for a grant. For example, the complete specification must be filed not later than twelve months after the provisional, and the application as a whole must have reached the stage of being "in order for acceptance" not later than eighteen months after the earliest filing date. In the same way renewal fees must be paid promptly as they fall due, or the patent will lapse. Extensions of time varying from one to three months can be obtained on payment of stipulated fees, but after that no extensions are allowed. In the *Electrical Review* of September 22, a "Legal Correspondent" writes an instructive article on the effects of the new patent legislation. The 'intellectual property' which is created by the operation of the patent system, as well as the artistic property which is called copyright, both stand in a class apart from the ordinary trade and business of mankind. It is therefore for the benefit of all that they should be safeguarded even when they come from an enemy source.

THE changes to be made in patent procedure, in order to meet the abnormal conditions of war, are set out in the new Patents, Designs, Copyright and Trade Marks (Emergency) Bill, to which the Royal Assent was given on September 21. The first clause of the Act states that any existing license granted under a patent does not become invalid simply because the proprietor or owner of the patent is an enemy. Clause 4 of the Bill preserves the right of an enemy, even during the period of hostilities, to apply for the grant of a British patent. At the end of the war of 1914–18, the sudden release of patents claiming priority-dates, which in some cases went back for five or six years before the specifications were formally accepted and published, naturally created considerable confusion and embarrassment. When the next armistice comes, we may reasonably expect that the experience gained in similar problems twenty years ago will stand us in good stead.

Food Production in War Time

THE Agricultural Research Council is to work in the closest co-operation with the Ministry of Agriculture and the Department of Agriculture for Scotland in connexion with research and investigations into problems that may arise from the food production campaign. Since March last a committee of the Agricultural Research Council has had under examination the programmes of research and the qualifications of the staffs of agricultural research institutes from the point of view of an emergency. It will be the function of the Council now to guide the research at these institutes into the special agricultural problems arising out of war conditions. For this purpose the chairman of the Agricultural Research Council (Sir Thomas Middleton) has, with the approval of the Lord President of the Council, appointed a small executive committee, which will keep all members of the Council in close touch with the situation.

THE Minister of Agriculture and Fisheries has also constituted an advisory panel the members of which will be available for consultation, as need arises, on the immediate technical problems of war-time food production which do not call for further research. The members of the panel are: Prof. F. L. Engledow (cereals and crops), Prof. J. A. Hanley (soils), Prof. H. D. Kay (dairying), Sir John Russell (plant nutrition), Prof. J. A. Scott Watson (general agriculture), Sir George Stapledon (grassland), Dr. T. Wallace (nutrition of horticultural crops), Dr. S. J. Watson (grass and fodder conservation), and Dr. H. E. Woodman (livestock and nutrition). The Secretary of State for Scotland will consult the agricultural colleges and the research institutes in Scotland on any technical questions on which their advice may be desired.

The Spirit of Adventure

THERE is no greater need in our time than the development of the capacity to weigh evidence and form sound judgments, and, having formed independent judgments, to have the reliance to stand by them. Although the main objects of Surgeon-Commander G. Murray Levick in leading expeditions of school-boys into uninhabited wilds is to widen outlook and to foster the spirit of adventure, one of the chief results must be the encouragement of independence and self-reliance; and no praise can be too high for the enthusiasm and skilled planning which has induced him to shoulder the responsibility of organizing and conducting seven such expeditions for the Public Schools Exploring Society which he founded in 1932. Three of the expeditions have been to Lapland and four to Newfoundland, which affords just those great areas of unmapped and uninhabited country which suit the needs of the young explorers.

(*Continued on page* 589.)

NATURE

SUPPLEMENT

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SHORT REVIEWS

Agriculture and Horticulture

Seed and Potting Composts

With Special Reference to Soil Sterilization. By W. J. C. Lawrence and J. Newell. Pp. 128. (London: George Allen and Unwin, Ltd., 1939.) 3*s*. 6*d*. net.

THIS lucidly written and well-illustrated book forms a report of the authors' experimental work designed to overcome difficulties experienced in making mixtures or composts of soil, complicated by the necessity of sterilization to prevent fungal diseases. A close scrutiny of the available materials was followed by tests of various methods and apparatus used for soil sterilization, on a larger scale suitable for commercial purposes, and on a smaller scale convenient for amateur gardeners. The more frequent causes of unsatisfactory results are listed in the text, and the methods are critically evaluated.

Two thoroughly tested standard composts are recommended. By the judicious use of powdered chalk and superphosphates, added after sterilization of the loam, satisfactory growth of the seedlings of numerous plants has been obtained in the first compost; in the second compost, used for many pot plants, nitrogen is provided in organic form by horn and hoof grist, but it has been found necessary to supplement this, especially for pot-bound plants, by the addition of nutrients relatively rich in nitrogen in solution. This solution is prepared from a proprietary general fertilizer with the addition of ammonium nitrate or sulphate.

The success of the author's methods at Merton and the growing and widespread adoption of their procedure in the industry form the best notice of their work, which has already enhanced the reputation of the John Innes Horticultural Institution held by practical growers.

The Study of the Soil in the Field

By G. R. Clarke. Second edition. Pp. 192+1 plate. (Oxford: Clarendon Press; London: Oxford University Press, 1938.) 6*s*. net.

MANY improvements have been made in the second edition of Mr. Clarke's book. It is unique among English (and most other) books on the soil in treating the subject entirely from the point of view of the student in the field and virtually ignoring the existence of the laboratory chemist and physicist. The true pedologist, says the author, should study the soil as an organism evolving under the influence of its environment, rather than as a subject for very impure chemical experiment.

Mr. Clarke tends to be somewhat dogmatic in his statements, and the inexperienced student will have to exercise care in accepting as facts what are expressions of the author's personal but usually well-founded opinions. Half the book describes the system worked out and used at Oxford for making and recording observations in the field, and the other half various systems of soil surveying and mapping used in different countries. Readers in some of these countries may object that their particular system has not received full justice, but what is lost in justice is gained in the simplicity of description which Mr. Clarke employs.

The book is intended to be carried in the pocket of the field worker, and will form a very valuable addition to his equipment.

Practical Lawn Craft

By R. B. Dawson. (Agricultural and Horticultural Handbooks.) Pp. 300+21 plates. (London: Crosby Lockwood and Son, Ltd., 1939.) 15*s*. net.

THE outstanding feature of this invaluable book is the thoroughness with which every detail connected with lawn craft is discussed. The combination of wide practical experience with exhaustive experimental work is evident throughout, and no aspect of the problem is too insignificant to be considered. An important feature is the comparison of the different management necessary for various types of sports grounds and for aerodromes, coupled with diagrams of the lay-out in several cases. The value of the book is much enhanced by the chapter on turf upkeep in other countries, which serves to correlate the various problems and to render the data of more general application. Amateurs and professionals alike owe a debt of gratitude to the author for his masterly presentation of a subject of such general interest.

W. E. B.

Anthropology and Archæology

Catalogue of Demotic Papyri in the British Museum
Vol. I: A Theban Archive of the Reign of Ptolemy I, Soter. By Prof. S. R. K. Glanville. Pp. lii+73+13 plates. (London: British Museum, 1939.) Paper, 33*s*.; cloth, 35*s*.

ALTHOUGH the collections of papyri in the British Museum contained demotic papyri so long ago as 1834, very little from them has been published. The catalogue which has been prepared by Prof. S. R. K. Glanville, using the short catalogue of Sir Herbert Thompson as a basis, will be completed in three volumes, of which the first, now issued, consists of a series from a single archive relating to a property at Thebes; the second will cover the literary documents, and the third will contain business and legal documents.

The collection of documents in the first volume dates from the reign of Ptolemy I Soter, with the exception of four receipts for payments, which fall in the reign of Ptolemy II Philadelphus. All are concerned with the history of a small property (or its owners) over a period of twenty-three years, during which time no less than nine persons successively acquired some sort of legal interest in it. What, however, is especially interesting is that the British Museum texts link up directly with other texts in the Rylands Library, in Philadelphia, and elsewhere, which take back the history of the estate for another quarter of a century, making up a record of its vicissitudes and of those of the family connected with it for just under fifty years. This material which, in addition to its reproduction, has been transcribed, translated and edited with a detailed commentary by Prof. Glanville, not only provides much interesting information in regard to neighbourly relations and the construction of dwelling houses in an ancient Egyptian city, but also affords a glimpse of the Egyptian theory of 'ancient lights'.

Racial Proverbs
A Selection of the World's Proverbs arranged Linguistically. By Dr. Selwyn Gurney Champion. Pp. cxxix+767. (London: George Routledge and Sons, Ltd., 1938.) 35*s*. net.

Proverbes et dictons Syro-Libanais; texte arabe, transcription, traduction, commentaire et index analytique
Par Prof. Michel Feghali. (Université de Paris: Travaux et mémoires de l'Institut d'Ethnologie, Vol. 31.) Pp. xviii+850. (Paris: Institut d'Ethnologie, 1938.) 187.50 francs.

(1) THE collecting of proverbs and gnomic sayings of the various peoples and nations of the world is an entertaining hobby; it is also an important subject of ethnographical research. For those who find it merely an entertainment it may be said that Dr. Champion's collection, to which he has devoted many years, is wider in scope and geographical distribution than any other of the same character; and it is provided with a full apparatus for the convenience of the reader in tracing any particular saying or phrase desired. Brief statements or analyses by different hands deal with the proverbial lore of each country or people; while Dr. R. R. Marett has some remarks to offer on the question of the proverb as an element in cultural studies. It must be said, however, that while some of these introductions are excellent—that on the Arabian proverb is an instance in point—not all are the work of authors of equal skill and authority. Indeed, one writer makes the remarkable admission that until three months previously to the time of writing he was unaware that the people with whom he deals had any proverbs at all!

Nor is the collection of proverbs itself above criticism. For English readers unacquainted with the original language or with the people, a literal translation is of little value unless the English equivalent, if there is one, is added. The least satisfactory section is the Greek, in which quotations from the poets appear as proverbs without remark, and no distinction is made as to whether the source is ancient or modern Greek. Scientifically, it is to be feared, as Dr. Marett seems to hint, this collection of proverbs can have little value. A proverb without commentary to explain its meaning and the conditions of its use cannot afford the assistance it should to an understanding of the mentality of its users, or throw light on their customs and beliefs.

(2) By way of contrast readers may turn to the second volume mentioned above—a detailed and extensive record of proverbs and sayings current in certain parts of Syria, in which are given original text, translation and detailed commentary. The result is a very complete picture, necessarily unsystematic, of the mentality, daily life, social relations and beliefs of the people.

Biology

Sveriges Skogsinsekter
Av Ivar Trägårdh. Pp. xii+509. (Stockholm: Hugo Gebers Förlag, 1939.) 20 kr.

WE welcome the appearance of a second edition of this standard work on Swedish forest insects. Its author, Dr. Ivar Trägårdh has been, for nearly thirty years, a prolific and enthusiastic student and writer on the subject of forest entomology. In this time he has made a name for himself as an authority of high rank. He is a familiar figure at international congresses, and has thus become known personally to many English entomologists.

The first impression upon looking through this volume is the excellence of its letterpress and the wealth of its illustrations (some 570 in number). These latter are nearly all examples of the half-tone process, and the majority are either original or borrowed from various already-published writings by the author. The book is divided into twelve chapters and, as might be expected, the most extensive is devoted to the order Coleoptera, while in the last five chapters the theory and practice of forest entomology are discussed. At the end there are diagnostic keys to the identification of forest pests under each kind of tree, the insects

being quoted under their vernacular names. A reliable, practical and scientific book of this kind, in its new edition, will doubtlessly be welcomed in Sweden in view of the great importance of forestry in the national economy. In other European countries a German translation would be an undoubted advantage. Finally, it may be added, almost all the English forest pests will be found to be discussed within its pages.

A Laboratory Introduction to Animal Ecology and Taxonomy

A Laboratory Guide with Keys prepared with Particular Reference to Freshwater and Terrestrial Habitats of the Deciduous Forest Region in North America. By Prof. Orlando Park, Prof. W. C. Allee and Prof. V. E. Shelford. Pp. x+272. (Chicago: University of Chicago Press; London: Cambridge University Press, 1939.) 10*s*. net.

THIS handbook is written for the naturalist, and is intended for those taking introductory college courses, interested amateurs and high-school students. Its object is to train the student to identify the terrestrial and freshwater animals of the Chicago area, to study their habits, to experiment with them in a simple way, and to find out what is known about them from books. References are given in each section, and there is an extensive bibliography. Problems are set to stimulate further investigation. There are synoptic keys, carried as a rule only to orders, and the student is encouraged to construct his own key by means of an exercise based on ten species of the local snail Polygyra. Pratt's "Manual of Common Invertebrate Animals" and Ward and Whipple's "Fresh Water Biology" are then used for the identification of genera and species. Statistical methods are lightly touched upon and a section on cave animals is included. A glossary of technical terms used in the keys supplements the explanations found in the text. There are seventeen clear line-drawings, mostly by T. J. Daggy. The pages are threaded on ten metal runners which keep the leaves flat when the book is open, but are somewhat awkward to manipulate. The book gives an admirable presentation of the subject.

Flora of Devon

Phanerogams, Vascular Cryptogams, Charophyta. Promoted by the Devonshire Association. Edited by Rev. W. Keble Martin and Gordon T. Fraser, with the assistance of Rev. Thomas Stephenson and Francis M. Day. Pp. xv+787+8 plates. (Arbroath: T. Buncle and Co., Ltd.; London: Wheldon and Wesley, Ltd., 1939.) 25*s*.

THE editors of this "Flora of Devon" are to be congratulated on the care and attention they have given to this long-awaited volume. Some seven hundred pages of print are devoted to a detailed study of the distribution of the plants found in the county, which for the purposes of this survey has been divided into two vice-counties (following Watson), eight districts and twenty-three sub-districts. Under each species and sub-species is given a list of the places in which it is or has been found and the records of the species in the district. This has entailed a careful study of the specimens in the herbaria in the county, consultation with the systematists who are specialists in the different groups, and an examination of the relevant literature, of which a bibliography is given.

The result is a very complete and careful record of all the data relating to each species and sub-species, which is grouped in accordance with the "London Catalogue of British Plants" (eleventh edition). For the specialist and the systematist the book should be of immense value. Its appeal and scope would, it appears to the reviewer, have been widened had the details given for each plant been somewhat curtailed, thereby allowing of more than forty pages for the introductory portion, which seems to be of more value to the general reader and student. The meteorological, geological and ecological data which are outlined in these first few pages are of great interest and some portions, at least, might have been expanded, to group, for example, the plants under localities, and not, as is found later in the book, the localities under the plants. Out of some eight hundred pages, more than twenty might, with effect, have been devoted to the ecology of the county. J. C.

Experiments in Plant Physiology

A Laboratory Text-Book. By Dr. Walter E. Loomis and Dr. Charles A. Shull. (McGraw-Hill Publications in the Botanical Sciences.) Pp. xiv+213. (London: McGraw-Hill Publishing Co., Ltd., 1939.) 12*s*.

THIS book consists of the first part of the authors' "Methods in Plant Physiology", which has been revised and rewritten. There are sections on colloids, water-relationships of the plant, photosynthesis, respiration, reserve foodstuffs, water-cultures, growth and tropisms, while a few experiments on growth substances have also been included. While most teaching physiologists, doubtless, will always prefer to devise their own teaching experiments, the present work is remarkably suggestive of fundamental practical work well within the capabilities of most intermediate and general class students. Two pleasing features are the questions added at the end of most of the sections, and the many references to recent literature (nearly all in English) on which the experiments have been based. The consequence should certainly be that the student will be induced to see beyond the actual experiment he has performed, and will try to relate it to the results of modern research.

One would have wished to see more attention being paid to various tests for reserve foodstuffs. A weakness of the book is the failure to include details of practical work on the physiology of the fungi: experiments on the effects of growing moulds on different carbohydrates, or at different temperatures or on media of various dilutions, should form part of any advanced course on practical plant physiology. But apart from this major criticism, it must be said that the authors have produced a very useful book which can confidently be recommended to university and college teachers.

Chemistry

Mellor's Modern Inorganic Chemistry

Revised and Edited by Dr. G. D. Parkes in collaboration with Dr. J. W. Mellor. Pp. xix+915. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1939.) 12*s*. 6*d*.

THIS new edition of Dr. Mellor's well-known book is practically a new work, the arrangement and text having been drastically changed. It is now more systematic and will be found much easier to read by junior students, although some readers who know the original work may regret the omission of the digressions which stamped the book with an original character. The first part now deals with theory, then come seven chapters devoted to hydrogen, oxygen, carbon, nitrogen, sulphur and the halogens, and their principal compounds, and then the remainder of the book discusses the other elements and their compounds in the order of the periodic table. The salts are now described under the metals. Most of the diagrams are new or have been redrawn, and some are not very satisfactory, essential parts being omitted, and in at least one case the diagram does not correspond with the description. In the description of atomic structure, the presence of electrons in the nucleus is postulated in the text.

The new edition of "Mellor" is a straightforward text-book of intermediate and pass standard which will undoubtedly maintain the popularity of the original work. The type is larger and clearer than that of earlier editions.

Casein and its Industrial Applications

By Edwin Sutermeister and Frederick L. Browne. (American Chemical Society Monograph Series, No. 30.) Second edition. Pp. 434. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1939.) 32*s*. 6*d*. net.

THIS book tells all about casein—a material which continues to increase in importance as an industrial raw material: there is much progress to record in the twelve years since the first edition. Casein is used in glues, in paper-making, in paints, in the leather industry, in foods and medicines, etc., and there are chapters under each of these headings packed full of information. The importance of casein as a plastic does not lessen in spite of the many alternative plastic materials. A remarkable coloured plate shows objects fabricated from casein.

The chemistry, manufacture, analysis and storage of casein also receive attention. There is a short note on synthetic textile fibres from casein, which concludes with the forecast that artificial wool fibre will eventually attain the commercial importance of rayon.

There are ten contributing authors, including the two whose names are on the title-page.

A Higher School Certificate Inorganic Chemistry

By Dr. E. J. Holmyard. Pp. xii+529. (London: J. M. Dent and Sons, Ltd., 1939.) 5*s*. 6*d*.

BY allocating space to individual topics roughly in proportion to the frequency with which those topics appear in examination papers, and keeping those sections which deal with stock examination questions within such limits as may enable the candidate to reproduce them or their substance in half an hour, and also by omitting or only briefly recapitulating work up to School Certificate level, the author has been able to present the material for Higher Certificate students in a relatively small compass. Examination questions are not given. The book is divided into two parts, the first containing theory and the second an account of the elements dealt with in the order of the Periodic Table. There is a short section on the electronic theory of valency. The tests for the important metals are given. Preparative details are only briefly stated, but manufacturing processes are described in the important cases in some detail. Dr. Holmyard's book is clearly and attractively written and contains a well planned course of the appropriate standard. A good feature is the presentation of equations for all the important reactions.

The Fundamentals of Chemical Thermodynamics

Part 1: Elementary Theory and Electrochemistry. By Dr. J. A. V. Butler. Third edition. Pp. xv+271. (London: Macmillan and Co., Ltd., 1939.) 7*s*. 6*d*.

THE general plan of the new edition of this book remains the same as that of former editions, but some sections have been revised. These include the chapters on electrochemistry, a simplified treatment of gas reactions, and a short section on semiquinones in the chapter on oxidation-reduction potentials. The book is very clearly written, and provides an excellent introduction to the subject for chemical students.

Engineering

Hydraulics

For Engineers and Engineering Students. By Prof. Frederick Charles Lea. Sixth edition. Pp. xii+757. (London: Edward Arnold and Co., 1938.) 21*s*. net.

THE issue of the sixth edition of Prof. Lea's "Hydraulics" is a remarkable event in these days, when the pace at which engineering science develops is such as in a few years to put out of date the great majority of treatises. In the thirty years since it first appeared, the author has kept successive editions well abreast of and in close contact with the most recent developments, and this has no doubt been in large measure due to the active part he himself has taken in scientific investigations and in the work of the professional institutions. Therefore, while the great body of unchanging hydraulic principles and their general applications constitute the main structure and usefulness of this volume, we find that, further to the previous additions, there have been included discussions on formulæ arising out of the most recent work on the flow of fluids in pipes and channels and over weirs. The tables and charts based on these should prove very useful when a coefficient has to be chosen for a particular case. Additions have also been made to show new designs of turbines and pumps, and a

description of the latest type of electric-hydraulic forging press is another of the added features which maintain the repute of the book as one of the foremost treatises on the subject of hydraulics.

Essentials of Alternating Currents

By Prof. William H. Timbie and Prof. Henry H. Higbie. Second edition. Pp. x+378. (London: Chapman and Hall, Ltd.; New York: John Wiley and Sons, Inc., 1939.) 11*s.* net.

DURING the last ten years there has been a wide expansion in the applications of alternating current power both for domestic use and in industry. The wide use of static condensers for improving the power factor, and the introduction of more efficient rectifying devices, have made a knowledge of the operating principles of these devices essential to the practical electrician, who is keenly alive to keeping abreast of the latest improvements. The second edition has been prepared with this end in view. Many practical men have forgotten much of the mathematics they studied at school, so the authors devote themselves to simplifying the mathematical wording as much as possible and giving graphical methods which, with the help of simple numerical tables, enable them to solve most of the practical problems they come across with the minimum of labour. The chapters on motors, starters and controllers, and on converters and rectifiers will be found useful to many.

Mathematics

A New Geometry for Schools

By Clement V. Durell. Pp. xvi+572+xxii. (London: G. Bell and Sons, Ltd., 1939.) 5*s.* 6*d.*

MR. DURELL'S "Elementary Geometry" appeared fourteen years ago, and the author has now decided to replace it by an entirely new book, recasting his treatment in the light of his own experience, the suggestions sent to him by others, and the recent Second Report of the Mathematical Association on the Teaching of Geometry. He gives a course from the first stage up to the standard of the School Certificate, developing each group of geometrical facts by the following successive stages: examples for oral discussion, numerical examples, formal proofs of theorems, and a carefully graded and classified set of riders.

Computation and Trigonometry

By Harold J. Gay. Pp. vii+143. (New York: The Macmillan Company, 1938.) 10*s.* net.

THE fifteen chapters of this book cover a wide field. The first three are concerned mainly with computation and contain much useful information on arithmetical accuracy, logarithms and the slide rule. Chapters iv–xii deal with plane trigonometry up to the solution of triangles, whilst the remaining three chapters are devoted to the elements of spherical trigonometry with some interesting applications. All the fundamental formulæ are summarized at the end and occupy no less than five pages. Throughout the text, the student is well supplied with exercises, but no answers to these appear to be provided.

In comparison with the course covered the book is somewhat large, but this is due to the fact that bound up with the text is a revised edition, running into over 142 pages, of logarithmic and trigonometric tables, prepared under the editorship of Prof. Hedrick. Most of these tables are given to five places and include compound interest, compound discount, annuity and American Experience Mortality tables.

Some Notes on Least Squares

By Dr. W. Edwards Deming. Pp. iv+181. (Washington, D.C.: Graduate School, Department of Agriculture, 1938.) 1.50 dollars.

THE method of least squares, developed largely by Gauss, and applied widely by astronomers and physicists in the last century, has taken on a new lease of life with its application to statistical problems. Students approaching the method from the statistical point of view are perhaps not as familiar as could be desired with the work of the older writers, and Dr. Deming is to be congratulated on presenting the subject in a way which stresses the continuity of its development. These notes are a mimeographed transcription based on lectures given by Dr. Deming in the Washington School of Agriculture. As the author points out in the preface, they were not assembled with the idea of forming a complete text on the subject, but they do perform a useful function in directing the student who wishes to go into the theory of least squares somewhat closely. Many numerical examples are worked.

Calculus

By Prof. Frederic H. Miller. Pp. xiv+420. (London: Chapman and Hall, Ltd.; New York: John Wiley and Sons, Inc., 1939.) 15*s.* net.

THIS is an account of the differential and integral calculus, with a chapter on infinite series and another chapter on differential equations. It is intended for American students of science or engineering, and also for those interested in mathematics for its own sake. It covers all the usual elements of the subject, going as far as partial differentiation and multiple integrals. There are many geometrical and physical applications, and more than 2,300 examples. The appendixes contain formulæ from other branches of elementary mathematics and useful tables.

Miscellany

A Vicarious Trip to the Barbary Coast

By Mary Berenson. Pp. xii+146+23 plates. (London: Constable and Co., Ltd., 1938.) 7*s.* 6*d.* net.

MRS. BERENSON, owing to ill-health, was unable to accompany her husband on a trip through Italian North Africa to visit the archæological sites and examine the collections of antiquities in the museums. From the detailed descriptions and the accounts of incidents on the journey, which were conveyed to her in letters, and with the aid of guide-books, maps, and authoritative works of reference,

she has constructed an account of her "Vicarious Trip" with illustrations. No one, naturally, will go to such a book for original research; but if they wish for a brightly written, informative account of the ground covered, and people encountered, together with a glimpse of what the authorities are doing to explore the archæological sites and preserve the relics of the past in this country, here they will find at least something to satisfy their desire.

Manuel de la conservation et de la restauration des peintures
(Office International des Musées.) Pp. 310. (Paris: Institut Internationale de Coopération Intellectuelle, 1939.) 150 francs.

SOME little time ago, a committee of specialists interested in the conservation and treatment of paintings met in Paris to discuss these activities in detail, and to agree so far as possible upon standard methods of policy and nomenclature. This book is the result of their labours. The separate contributions have been co-ordinated with the view of obtaining constancy of style: this editorial work has been very ably carried out. However, the various sections are by no means equally successful in their subject-matter; for example, the description of methods available in the restorer's studio is admirable, whereas the information relating to radiography and what it can do is extremely sketchy.

So far as the more truly scientific aspects are concerned, the impression is given that the writers sometimes have little personal experience of the processes involved; there is a lack of contact with things as they are in the laboratory.

The bibliography, in spite of an editorial disclaimer, is restricted, and provides a very narrow view of how much has been accomplished in various countries of the world. The volume ends with an excellent glossary (French-English-German-Italian), which curators and others will heartily welcome.

F. I. G. R.

Forty Acres and Steel Mules
By Herman Clarence Nixon. Pp. vii + 98 + 32 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1938.) 2.50 dollars; 11*s.* 6*d.*

THIS very clear and straightforward account of the emergence of the Southern States from plantation slavery and their subsequent submergence under another kind of slavery, in which share croppers and tenants bleed the exhausted soil to pay their feudal dues to absent landlords and small-town traders, illustrates the immense problems of social reconstruction confronting the American cotton belt. The author paints a most depressing picture of the present 'dark age' and does not minimize the difficulties of bringing light into it. He proposes a comprehensive scheme of social, agricultural and industrial readjustment which reads like sound common sense and would have been unnecessary in a world where common sense had prevailed. The book is very graphically illustrated.

An Introduction to Astronomical Navigation
By P. H. Legg. Pp. xiii + 102. (London: Chapman and Hall, Ltd., 1939.) 10*s.* 6*d.* net.

WITH the increase in range and speed of aircraft, the use of astronomical observations to fix the position, independently of observations of ground objects, has become of increasing importance. When flying above continuous cloud or over the ocean, astronomical observations provide the only means of determining the position. In this elementary introduction to astronomical navigation, the means are described by which a position line can be drawn on a map as the result of an observation of altitude of the sun, moon or a star.

The treatment is very detailed and elementary, no previous knowledge of the geometry of the sphere, of the definitions of astronomical quantities or of methods of navigation being assumed. Yet terms such as 'meridional parts' and 'rhumb line' are introduced without explanation. Some familiarity with navigational tables and with the Air Almanac seems to be presupposed. It would have been more in accordance with the scope of the book to assume no such knowledge, to have explained what data are given in the Air Almanac and why the data are given in the form they are, and to have given some description of various tables and other aids to the reduction of the observations.

The dead reckoning position is employed for constructing the position line. The advantage, when using navigation tables, of using an 'assumed position', near to but not necessarily coincident with the dead reckoning position, is not mentioned.

H. S. J.

Philosophy

Medieval Number Symbolism
Its Sources, Meaning and Influence on Thought and Expression. By Prof. Vincent Foster Hopper. Pp. xiii + 241. (New York: Columbia University Press; London: Oxford University Press, 1938.) 15*s.* net.

THE significance of number goes far beyond the pragmatical uses of computation and the abstract necessities of its mathematical treatment. The Pythagorean tradition of linking number with every human interest, which asserted itself in the mystical developments of neo-platonism as well, found a considerable field of application in the religious interests of the Middle Ages. By symbolism, the abstract is brought into the realm of the concrete, where it is immediately recognizable and meaningful. Thus, the abstract beauty and loving-kindness of the Deity were humanly realized in the person of the Virgin, the concept of which was brought ever closer to sense experience through the artistic media of sculpture and painting. The author endeavours, on the basis of the number symbolism of earlier periods which has been studied at length by various experts, to explain the basis, meaning, purpose, extent and use of number symbolism in the Middle Ages; and has chosen the "Divina Commedia" of Dante as a specific example of his interpretation. Prof. Hopper's work, which is more historical and

descriptive than philosophical, might have been strengthened by a discussion of the medieval theories about signs and symbols which are expounded by the leading theologians of the period surveyed. As it is, it will serve a useful purpose in enabling one to understand one of the most original aspects of medieval thought. T. G.

The Kantian Philosophy of Space
By Prof. Christopher Browne Garnett, Jr. Pp. xi + 287. (New York: Columbia University Press; London: Oxford University Press, 1939.) 17*s.* 6*d.* net.

THIS is a valuable discussion of the theories of space due to Newton and Leibniz, the development of Kant's views, beginning with his earliest work, and of some modern theories. As against Leibniz, Kant held that space must be in some sense prior to bodies that move, if there are to be universal laws of motion; as against Newton, that empty space, an infinite no-thing, cannot have absolute reality. Modern views tend to be either Leibnizian or Newtonian, or, if the inherent difficulties are realized, Kantian. Kant finally arrived at two inconsistent theories, but between them they seem to exhaust the possibilities.

Essai sur les origines intuitives du positivisme
Par Dr. Pierre Ducassé. (Bibliothèque de philosophie contemporaine.) Pp. x + 272 + 4 plates. (Paris: Félix Alcan, 1939.) 50 francs.

Méthode et intuition chez Auguste Comte
Par Dr. Pierre Ducassé. (Bibliothèque de philosophie contemporaine.) Pp. x + 620. (Paris: Félix Alcan, 1939.) 80 francs.

THESE two books constitute a sympathetic exposition of Auguste Comte's positive philosophy in relation to his life and the development of his thought. Dr. Ducassé is more readable and less dogmatic than Comte himself. His work should do something to revive interest in a thinker once hailed as the founder of a new universal religion and now too much neglected. As the prophet of the application of scientific method to the study of human life and society, if for nothing else, Comte deserves to be studied.

Physics

Angewandte Kristallstrukturlehre
Ein Hilfsbuch zur Bestimmung von Kristallstrukturen. Von Dr. E. Brandenberger. Pp. vii + 208. (Berlin: Gebrüder Borntraeger, 1938.) 12 gold marks.

THIS volume constitutes an excellent work of reference for theoretical studies and computations accompanying crystal analysis. It contains a clear account of structure-topology which is all too rare. For the rest, the discussion follows traditional lines in dealing with the nature of symmetry, translations, point-groups, space-groups, symmetry axes, and the complete formal solution of spatial systems. The numerous figures in the text are clearly drawn, and some of them (so far as the reviewer's experience goes) are original and decidedly revealing. F. I. G. R.

Proceedings of the Sixth Summer Conference on Spectroscopy and its Application
Held at the Massachusetts Institute of Technology, Cambridge, Mass., July 18–20, 1938. Pp. viii + 172. (London: Chapman and Hall, Ltd.; New York: John Wiley and Sons, Ltd., 1939.) 15*s.* net.

IN this volume, spectroscopy is little more than a thread binding together investigations on many diverse problems, physical, chemical, biological, etc. There are thirty-one papers more or less unco-ordinated, covering a wide field of subjects. On one hand, there are purely technical discussions dealing with instruments, wave-length standardization, photometric technique, and the properties of photographic emulsions. On the other hand, there are examples of chemical analyses, ranging to the extreme case of the application of the spectroscope to the detection of crime. The analyses described follow either the well-known method of emission-line spectra or the alternative method of absorption spectra, so useful in the case of complex organic compounds, of proved value, for example, in the standardization of vitamin preparations. One of the most interesting of the papers describes an extension of this type of work in the use of absorption spectra for fixing the structure of vitamin B_1. There is also a note on still a third method of chemical analysis, the use of fluorescence spectra, by which, for example, the presence of bacteriological contamination can be detected in a cigarette. On the whole, such biological applications of spectroscopy seem to stand out in interest, in that they point the way to a large field of future research. H. W. B. S.

The Nature of Crystals
By A. G. Ward. (Blackie's Tracts on Recent Physics.) Pp. ix + 114 + 4 plates. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1939.) 3*s.* 6*d.* net.

THIS is a refreshing little book. It is a very good introduction indeed to the new crystallography, but at the same time there is considerably more in it than that. Above all, it is a revolt—and an exceedingly well-planned one—against the excessive professionalism of science with which we seem to be afflicted. Actually, the reader is conducted skilfully through the subjects of formal and chemical crystal structure, and he is asked to delight in knowing the reasons why materials have the properties which in fact they display. Whether, however, the inquirer will leave his easy chair (as the author requests him to do) and "get busy" with a few crystals, test-tubes and dishes is another matter, but he will be the happier—and the wiser—if he can and will.

Some very sound advice is offered for the making of models, and it is clear that these need be neither troublesome to construct nor unduly expensive.

Naturally, these pages will not by themselves produce a crystallographer, while the theorists might almost deny that the contemplation of natural things can give pleasure. Again, it is all rather more

difficult. But Mr. Ward—and Prof. Bernal, with his stimulating preface—have produced something at once original and charming. F. I. G. R.

Physics To-day

By John A. Clark, Frederick Russell Gorton and Francis W. Sears. Pp. vi+634+x. (London: Constable and Co., Ltd., 1939.) 8*s*. 6*d*. net.

ON account of the differences in the educational systems of the two countries, an American text-book of elementary physics can seldom be used as a text-book in Great Britain. There can be no doubt, however, of the usefulness of the present volume, by three American physicists, to all teachers of elementary physics. The fundamental laws and principles are set out briefly and simply with plenty of illustration. The outstanding feature of the book is the vitality and up-to-dateness of the linking of physical principles with laboratory experiments and with everyday life. With the increasing use of the epidiascope, the book is worth buying for the 750 illustrations alone. They consist of some conventional diagrams to illustrate physical principles together with many diagrams and actual photographs of simple experiments in progress, photographs of practical applications and portraits of all the famous physicists. As a typical example, the subject of levers is illustrated by a photograph of two men using a long pole to raise a car which has sunk up to the axles in mud. The picture is so clear that an estimate can be made of the mechanical advantage. The lever principle in the typewriter and in commercial scales of the newer pattern without springs is the subject of two very clear diagrams amongst a total of fourteen illustrations on levers.

The mixing of philosophy with physics and a loose use of the word 'why' is in striking contrast with the general excellence of the book. The reader is told that "you, like people of all times, want to know the 'why' of things. . . . Physics . . . aims to give you an understanding of both the 'how' and the 'why' of them". Chapter i starts with the question: "Is a solid body *really* solid?" However, the mixing of philosophy with physics, like the mixing of theology with ethics, is a matter of taste, and the volume can be very strongly recommended to all teachers of elementary physics in schools and colleges.

W. H. G.

Electricity

By Dr. T. F. Wall. (Home University Library of Modern Knowledge, No. 190.) Pp. 256. (London: Thornton Butterworth, Ltd., 1939.) 2*s*. 6*d*. net.

DR. WALL'S interesting survey of the principles and applications of electricity is a valuable addition to the Home University Library of Modern Knowledge. Even the most recent applications are included. In spite of the condensation essential for the treatment of so comprehensive a subject in so small a space, there is no superficiality. The general reader will here find a trustworthy guide to the remarkable penetration of the use of electricity into every sphere of human activity. Food, clothing, housing, hygiene, health, transport and entertainment are all adequately covered. Simple calculations can be made by the aid of the appendix. The volume would also be excellent vacation reading for university students about to study physics in a degree course, or for those specializing in biological subjects, where electrical apparatus is proving increasingly useful.

W. H. G.

Psychology

Psychotherapy

By Dr. Paul Schilder. Pp. 344. (London: Kegan Paul and Co., Ltd., 1938.) 15*s*. net.

DR. PAUL SCHILDER has given us a very good account of his views on psychotherapy. Generally speaking, his views are psychoanalytically determined, although he is by no means an orthodox Freudian according to the purists. At the same time he incorporates just as much of the work of Jung and Adler as he thinks necessary in his psychotherapeutic technique. He dismisses relaxation as scarcely usable in the everyday approach to the patient. We think this is a pity, as this method does play a part in psychotherapy even although it may be largely suggestive in application. We do not agree with the statement that "the hospital situation makes the adaptation too simple for him" when referring to the psychoneurotic.

A Manual of Psychology

By Dr. G. F. Stout. Revised, in collaboration with the author, by C. A. Mace; with an Appendix by Dr. R. H. Thouless. Pp. xix+708. (London: University Tutorial Press, Ltd., 1938.) 12*s*. 6*d*.

TO those of us who were brought up on "Stout" it is a great pleasure to see a fifth edition. There is no alteration from the fourth edition except the addition of an appendix on Gestalt by Dr. Thouless and a note giving Prof. Stout's views.

Dr. Thouless gives a very good brief account of *Gestalttheorie*. Prof. Stout accepts Gestalt psychology in general, but is not satisfied with the Gestalt psychology of sense-perception. The Gestalt psychologists seem to deny much importance to past experience in perceptual processes and to neglect the difference between sensation and perception.

Personality in Formation and Action

By Dr. William Healy. (Thomas W. Salmon Memorial Lectures.) Pp. 204. (London: Chapman and Hall, Ltd., 1938.) 8*s*. 6*d*. net.

THE Salmon Memorial Lectures for 1937 were delivered by Dr. W. Healy, director of the Judge Baker Guidance Centre in Boston. Personality is defined as "an integrated system of habitual adjustments to the environment, particularly the social environment".

The author gives a very competent account of the development of the personality in childhood, its actions and reactions in adulthood, and the wider implications which are met with in national and international life.

At a meeting early this year of the Royal Society of Arts, Commander Levick gave an account of the 1938 expedition to Newfoundland, and it is clear from his description that the boys enjoyed the experiences and must have gained enormously from them (*J. Roy. Soc. Arts*, **87**, 970, Aug. 1939). In recent expeditions a number of boys from secondary schools have been included in the party, and the Astronomer Royal, who was in the chair, pointed out that the public schoolboys and the secondary schoolboys had a great deal to gain from this contact with each other and from collaboration in such an enterprise.

Field Archæology in War Time

ARCHÆOLOGISTS nowadays for the most part, having other preoccupations, have ceased investigations in the field. Nevertheless, experience in the last war showed that military operations may bring to light evidence which, when recorded with such note of the conditions of discovery as circumstances permit, may point the way, as happened in the Macedonian campaign of 1915–18, to further and valuable fields for further research in later days of more assured tranquillity. The valuable collection of prehistoric antiquities at Salonica is not only an enduring monument to the devotion to archæological studies and the *flair* of those archæologists who served in the forces in that theatre of the war, but also, on the cessation of hostilities, it served as the starting-point of a series of investigations in the Macedonian field which have thrown a flood of light on cultural movement in this borderland of prehistoric Greece. Nor should it be allowed to be forgotten that it was directly out of Dr. R. C. Campbell-Thompson's military service in Mesopotamia, which afforded him opportunity for an archæological reconnaissance, that there grew the joint expedition of the British Museum and the University of Pennsylvania to Ur, at first under the direction of the late Dr. H. R. Hall, and later of Sir Leonard Woolley—as a whole, and in its effect on study of the growth of early civilizations, which is still far from being exhausted, one of the most momentous in a long series of discoveries in the history of archæology.

SUCH opportunities in the field overseas are not likely to recur—indeed it is permissible, without risk of misunderstanding, to hope that they will not. But already on the home front a number of finds, recorded in connexion with A.R.P. and other military or defensive activities, bear witness to the vigilance of local archæologists and their solicitude that any evidence of antiquity brought to light shall not escape record. Among the latest finds reported is a discovery at Canterbury (*The Times*, Sept. 25), where in excavating a trench at the Simon Langton schools, on the site of the White, or Austin Friars' former buildings, material of considerable archæological interest has been brought to light. A passage, built of chalk blocks and believed to lead to the Cathedral, is stated to have been found at this point about twenty-five years ago. The site is also known to cover extensive Roman remains; but unfortunately, the need for haste demanded the use of a mechanical excavator and precluded scientific examination of the stratigraphic record. Most of the relics found were of medieval date, and included massive parts of what are believed to be the base of the Friary buildings, a simple medieval copper ring, a sixteenth-century inscribed German jetton, and human bones in no particular order, as well as an undisturbed east-to-west Christian burial. The copper ring was six feet below the surface in an early, probably medieval, cemetery. Of still greater archæological interest was the evidence of a Roman kitchen midden, from which were obtained much broken pottery coated with soot, some fragments of Samian ware, and quantities of burnt wood. These finds were associated with a bed of oyster shells.

Reports of the Australasian Antarctic Expedition

SLOWLY the reports upon the extensive collections made in Antarctic seas by Sir Douglas Mawson's Expedition of 1911–14 are being completed and published (**1**, part 3; **2**, part 4; **2**, part 8. Sydney: Gov. Printer). Among the zoological contributions are Prof. T. Harvey Johnston's "Parasitic Infusoria from Macquarie Island" which include ciliates from a lamellibranch and a suctorian from an Asellid crustacean, both of which appear to be new to science; an account of forty species of Pycnogonida, among which Decolopoda is not represented, by Dr. Isabella Gordon; and a description by Prof. G. E. Nicholls of seven genera and twenty-six species of Gammarid Amphipods new to science, in a collection which includes ninety species representative of sixty genera.

Earthquake near Smyrna

AN earthquake of considerable intensity shook the district around Smyrna on Friday, September 22. In Smyrna itself more than 200 people are reported killed, many more injured and 5,000 are without shelter. In the surrounding district several villages have been almost destroyed. During the remainder of Friday and Saturday, aftershocks have occurred almost continuously, accompanied by underground rumblings. This region of Asia Minor is liable to earthquakes and earth tremors. Smyrna was affected by an earthquake which was destructive also at Aidin and places in the Meander Valley on September 20, 1899, though on that occasion the epicentre was somewhat to the south of the present one, being then near lat. 37·5° N., long. 27·5° E. A destructive earthquake again affected Smyrna on March 31, 1928, the epicentre on that occasion being calculated from the readings of 96 seismograms to have been at lat. 38·5° N., long. 28·0°E., somewhat inland to the east of Smyrna. Further data concerning the present shock will no doubt be somewhat delayed, though it appears to have been sufficiently intense to have affected seismographs throughout the world.

Other Recent Earthquakes

AN earthquake of moderate intensity was recorded at Kew Observatory on September 15. The *P* waves started at 23h. 21m. 42s. G.M.T. on the seismogram

and the epicentral distance has been calculated to be provisionally 2,690 km. On September 18 an earthquake was reported as having had its epicentre approximately 50 miles from Vienna. This shock damaged nearly all the buildings in the small village near the epicentre, and two people are reported killed. On September 20 several earth tremors were experienced in Greece. Early in the day severe shocks rocked the town of Patras, and much apprehension was caused, though there appears to have been no resultant damage or loss of life. Shocks were felt also in several parts of the Peloponnesus, including Pyrgos, though here also no damage is reported. Minor tremors are relatively common in Greece, though shocks such as the one of April 22, 1928, which partly destroyed Corinth, are not so frequent. The last severe earthquake in Greece was probably that of July 20, 1938, which did damage at Scala Oropos and adjacent villages.

Protection of Wild Birds

WE understand that the Royal Society for the Protection of Birds has under consideration the drafting of a Bill to amend and consolidate the existing Acts for the protection of wild birds. Such a measure is highly desirable in view of the complexity of the present laws dealing with wild birds. The general lines upon which new legislation should proceed is indicated by certain resolutions drawn up by representatives of the County Councils Association and of municipal corporations, and referred to in the report for 1938 of the Royal Society for the Protection of Birds: (1) that as the complexity of the existing law had led to difficulties in administration, there was, in the opinion of the Conference, a strong case for consolidation and simplification; (2) that protection should be afforded to all wild birds, their nests and eggs, throughout the whole year, with specific exemptions which should be the subject of further discussion; (3) that meantime the Home Office be asked for its views on the matter.

As earlier attempts have shown, it is no easy matter to draft a Bird Protection Bill which is simple, affords all the protection required, and at the same time avoids the danger of opposition from interested persons who may block its passage through Parliament. But with good will and a willingness to compromise on points not vital to the essential interests of wild birds, it should be possible to draft a Bill which would commend itself to reasonable opinion and obtain the assent of Parliament. On the other hand, possible competition between Bills drafted by different bodies, such as for example the Royal Society for the Protection of Birds, the Scottish Society for the Protection of Birds, and perhaps the Home Office, should not be allowed to obscure the need and demand for new and simplified legislation, or, when conditions are more favourable, to delay its speedy passage to the Statute Book.

Value of Fruit Juices

THE possibility of cessation or restriction of supplies of citrus fruits or other fresh fruit juices from abroad makes some recent work carried out at the Long Ashton Research Station, Bristol, of particular value at the present time (Long Ashton, Ann. Rept. 1938). Canned black currant juice would appear to be of special importance. It has a high content of both vitamin C and iron, and has proved extremely useful in cases of ulceration of the stomach and duodenum or hyperacidity. Similarly, apple juice has been successfully used in the treatment of pink disease (erythroœdema). Information obtained from Switzerland and Germany supports the view of the medical significance of fruit juices, claims being made that they are of benefit in other diseases such as diabetes, inflammation of the lungs or kidneys. The writer suggests that closer co-operation with the medical profession in England is desirable, in order that the true facts and significance regarding the use of fruit juices should be discovered and the danger of any false claims be avoided.

Ordnance Survey Plans

IN a paper prepared for the British Association meeting at Dundee, but not delivered, Brigadier A. B. Clough outlined the recommendations of the report of the Committee appointed in May 1935 to consider the revision, scales, styles, etc., of Ordnance Survey maps. The recommendations may be noted even if delay must now ensue in the fulfilment of some. The principal points are these: (1) that no changes be made in the scales of existing maps; (2) that the large-scale maps be rearranged so as to form a single national series instead of thirty-nine separate county series; (3) that the revision of the large-scale plans be a continuous rather than a periodic process; (4) that a new series of maps be introduced on a scale of 1 to 25,000; (5) that a grid be superimposed on all Ordnance maps. Several subsidiary and consequential recommendations follow, namely, that all large-scale plans should be square, that each 1 to 2,500 plan should cover 1 square kilometre of country, and that the metre should be the unit of measurement for the grid. It is also suggested that additional contours should be added to the six-inch map, and that the practice of publishing archæological maps should be continued.

Research in Freshwater Biology

THE seventh annual report for the year ending March 31, 1939, shows that the Freshwater Biological Association of the British Empire is flourishing. The director, Dr. E. B. Worthington, in his review and forecast, states that in last year's report it was forecast that the year now under review would see the launching of new ventures by the Association, building on the foundation laid down during the previous seven years of the Association's history. Of these new developments, three are of primary importance. First, the investigation of the bacteria of fresh water, financed by the Department of Scientific and Industrial Research, has started and the changes in the bacterial flora of Windermere and other waters have now been followed through nearly a whole annual cycle. Secondly, the investigation of

coarse fish, financed by the fishery interests themselves, has commenced, and after a preliminary period of exploring possibilities, a sub-station for this special study has been set up in Cambridgeshire. Thirdly, a scheme for close co-operation between Wray Castle and the former Avon Biological Research, situated in the southern chalk stream area, came into effect from April 1, 1939. Under this scheme the Avon Research henceforth becomes a part of the Association as the "University College, Southampton, Branch for Southern Rivers". It will work under the scientific guidance of the Association while retaining its own individuality of control, and the advantage of being still closely associated with the University College. Thus the position of the Association is improved in every way, and, judging from the report on the work done, one may expect much valuable work in the future.

The Warsaw *Akwarium*

THE *Akwarium*, a new magazine published for the information of aquarium keepers in Poland, had run only half the course of its first volume when more serious affairs brought it to an end. The last number (6-7) is a well-balanced guide to aquarium interests, dealing with methods of constructing aquaria, circulating and heating the water; with natural aeration by plants and artificial aeration; and with several of the creatures which have become standard inhabitants of the aquarium. Descriptive articles discuss among other things the alligator, some bizarre varieties of gold-fish, and the Egyptian mouthbreeder, *Haplochromis multicolor*, the curious habit of which is to hatch the eggs and protect the young within the cavern of their parent's mouth. We hope that before long the *Akwarium* may resume publication from Warsaw under happier and more settled conditions.

Social Distribution of University Education

IN a paper on the social distribution of university education which was given before the Royal Statistical Society on March 21 (*J. Roy. Statist. Soc.*, 102, Part 3), Prof. Major Greenwood discusses the data of whole-time higher education, with particular reference to social class and such foreign experience as is available. Even with a stringent allowance for the difference of mean intellectual levels, it appears that under present conditions a large number of children of ability fit to profit from higher education do not receive it. Prof. Greenwood, however, concludes that the primary importance of university education, so far at least as concerns whole-time university education, is vocational, and as a matter of parental and governmental philosophy this fact is complacently accepted. On this philosophy no large increase of the whole-time university population should be expected. Data, however, about part-time higher education are incomplete, and the matter is of great importance, because increased leisure, which renders higher education possible for numbers greatly exceeding those before, is distributed through life, not concentrated in a few years of complete leisure. In commenting on the paper, Prof. A. M. Carr-Saunders pointed out that the number of those intellectually fit to profit from university education was very much larger than the number required to recruit the professions. He believed it should be the aim of the universities to bring under their care all who could profit fully from university education.

The Lingard Festival

THE festival recently held at Stockholm in commemoration of the centenary of the death of Per Henrik Ling, the founder of scientific gymnastics, was attended by nearly eight hundred athletes from thirty-four countries, who took part in the many displays of various methods of training and education for fitness. The general opinion of experts was that the standard of efficiency was remarkably high and proved that the principles on which Ling founded his system still offered a firm basis for popular physical education, though the details had undergone considerable modification in recent years. The British delegates at the Lingard and the subsequent gymnastic congress included Mr. Kenneth Lindsay, Parliamentary Secretary to the Board of Education, Lord Aberdare and Lord Dawson of Penn as representatives of the National Fitness Council of England and Wales, Lord Burghley, president of the Amateur Athletic Association, and others.

A Big Sunspot

FOR the third time during September, a large naked-eye sunspot group has occurred. The last of these is a giant single spot crossing the disk between September 22 and October 4 with central meridian passage on September 28·0. Near the east limb the spot had an area corrected for foreshortening of more than 1,500 millionths of the sun's visible hemisphere. This spot is the return of an even larger spot (NATURE, Sept. 16, p. 508) which crossed the disk between August 26 and September 7.

The Night Sky in October

ON October 1 in the latitude of London, night (sunset to sunrise) lasts for 12·3 hours and on October 31 for 14·3 hours; civil twilight (the sun 6° below the horizon) shortens the night by more than one hour. The moon is new on October 12 at 20·5h. and full (the Hunter's Moon) on October 28 at 6·7h. U.T. There is an occultation of the third magnitude star, β Capricorni, on October 20, the disappearance as seen from Greenwich taking place at 17h. 52·0m. at position angle 42° and the reappearance at 19h. 4·7m. at position angle 282°. On October 28 there is a partial eclipse (magnitude 0·992) of the moon that is partly visible from London. The moon enters the earth's umbral shadow at 4h. 54m., reaches mid-eclipse at 6h. 36m. (13 minutes before moonset at London) and leaves the umbral shadow at 8h. 18m. This lunar eclipse is preceded by a total eclipse of the sun on October 12 visible in the Antarctic Ocean south of Australia, the limits of latitude for the central line of totality lying between 60° 0′ and 81° 28′ south. Lunar conjunctions

with the planets occur as follows: on October 13 with Mercury; on October 21 with Mars; on October 25 with Jupiter and on October 27 with Saturn. Mars souths at about 19½h. in mid-October; Jupiter at 22½h., and Saturn at 0½h. Saturn is in opposition to the sun on October 22 when the planet's distance from the earth is about 772 million miles. Close groupings of Jupiter's four inner satellites can be seen at 22½h. on October 24 and 25; in the 24-hour interval, satellites I, III and IV have swung from west to east of the planet. On October 19–20, Jupiter occults the ninth magnitude star B.D. −1°3. At Greenwich the immersion takes place at 22h. 3m. and the emersion at 0h. 6m. As the motion of Jupiter is retrograde at the time, the immersion takes place at the planet's west limb. The computed times are liable to an error of some minutes owing to the slow motion of the planet. From a radiant in Draco a meteor shower associated with the comet Giacobini-Zinner (1900) may occur between October 8 and 10. The zodiacal light may be observed before dawn in the middle of the month. On moonless nights it is also worth looking for auroras, for the sun is still active and there is a pronounced seasonal peak in the frequency of magnetic storms in October, another peak occurring in March.

Scientific and Technical Institutions

THE rooms of the Royal Astronomical Society in Burlington House, London, have been closed until further notice; all communications should be addressed to the Assistant Secretary of the Society at the University Observatory, Oxford.

The offices of the Royal Society of Arts have been removed to Buxted Park, Sussex; correspondence should be addressed to the Secretary of the Society, c/o Basil Ionides, Esq., Buxted Park, Sussex.

The Institution of Mechanical Engineers is carrying on the bulk of its work at The Meadows, Bletchworth, Surrey, but the Institution building in Storey's Gate, London, will remain open for dealing with personal inquiries and for members or others wishing to make use of the library.

The offices of the Iron and Steel Institute at 4 Grosvenor Gardens, London, S.W.1, are remaining open, and the Joint Library and Information Department will be available for consultation by members and the industries. Two volumes of the *Journal* for 1939 are being issued, in September 1939, and January 1940, respectively. The publication of a *Monthly Journal*, the first number of which was to have been issued in January 1940, has been deferred.

The head office of the Institute of Fuel has been removed to 30 Bramham Gardens, London, S.W.5. The ordinary meetings of the Institute are suspended for the time being, but it has been decided to continue publication of the journal. Mr. H. A. Humphrey will deliver the Melchett Lecture, on "The Supply of Explosives during the Last War and the Early History of Billingham", at a luncheon to be held on October 19.

The offices of the Institute of Physics and the *Journal of Scientific Instruments* have been removed to the University of Reading, Berkshire.

The offices of the Institute of Wireless Technology have been transferred to 25 Firs Drive, Palmers Green, London, N.13; for the duration of the war, examinations will be held only once a year.

Announcements

CONTRARY to what has already been published, the majority of the departments of the Imperial College are remaining at South Kensington; only the Mining Department is going to Camborne and the Metallurgy Department to Swansea. All other departments are preparing to begin normally on October 10, this being possible through the provision of adequate shelters in the basements.

THE Royal Botanic Gardens, Kew, are now open every day from 11 a.m. until 4.30 p.m., but should daylight air raids take place, then no doubt the Ministry of Agriculture will close them again. The plant houses are open from 1 p.m. until 4.15 p.m. but the museums will remain closed. Only three of the gates will be open: the Main Gate, Victoria (opposite Kew Gardens Station) and the Lion at Richmond end. Visitors to the Gardens go there at their own risk, as there are no air-raid shelters in the Gardens.

DR. E. PALMÉN has been appointed director of the Thalassological Institute, Helsinki.

THE University of Toronto has received from the Rockefeller Foundation a gift of 250,000 dollars, a third of which is to be spent on researches on insulin and dementia præcox.

KING GUSTAV OF SWEDEN has devoted the money collected on the occasion of the thirtieth year of his reign, amounting to five million kronen, to the foundation for the study of paralytic diseases, especially poliomyelitis, and to the campaign against tuberculosis.

AN honorarium of a thousand dollars to promote research work in ophthalmology is offered through the International Association for the Prevention of Blindness. The subject is simple non-inflammatory glaucoma. Further information may be obtained from the Secretary of the Association, 66 Boulevard Saint-Michel, Paris.

THE Fleming Manufacturing Company, Providence, R.I., has constituted a fellowship for the study of the design, construction, and operation of oil filters in the Mellon Institute. Dr. Glenn O. Ebrey, who has been appointed to the incumbency of the fellowship, received his professional education at Illinois College and at the University of Pittsburgh. During 1931–32 he was research chemist with the Sinclair Refining Company, research and development division, East Chicago, Ind. For the past seven years he has been chief chemist of the Pennzoil Company, Oil City, Pa.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 600.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Nature of the Nebular Red-Shift

FROM an investigation (to be published in *Physica*) of the proper vibrations of expanding spherical space, it follows that—in extremely good approximation—light is propagated with respect to co-moving co-ordinates irrespective of the expansion, except that (*a*) the time-rate of events is slowed down and (*b*) all energy portions decrease, both inversely proportional to the radius of curvature.

The slowing down secures the constancy of the velocity of light and entails the nebular red-shift, which from this point of view takes place *during the passage*. The attempt[1] to decide by observation, whether it is actually due to expansion, rests on two important formulæ, which follow from the new view with great ease. Let l be the linear diameter of a nebula *at the moment of emission* and χ its angular distance from the observer (linear distance divided by the circumference of space), then the angle $d\theta$ between two geodesics of space, pointing at the moment of emission from the observer to the ends of the diameter, is from pure geometry:

$$d\theta = \frac{l}{R \sin \chi}, \qquad (1)$$

R being the radius of curvature at the moment of emission. By the theorem quoted above, $d\theta$ is also the observed angular diameter of the nebula (Hubble and Tolman, equation 3).

Again, let the energy emitted by the nebula within an appropriately chosen unit of time be E_0. It will soon assume the shape of a spherical shell of thickness c (say). Let $R_{obs.}$ be the radius of space, when this shell reaches the observer. Its surface at this moment is, by pure geometry, $4\pi R^2_{obs.} \sin^2\chi$. By the theorem quoted above, its thickness then is $c\,R_{obs.}/R$ and its energy is $E_0\,R/R_{obs.}$. Hence its energy density ρ is

$$\rho = \frac{E_0}{4\pi c\, R^4_{obs.}} \cdot \frac{R^2}{\sin^2\chi}. \qquad (2)$$

ρ is a measure of the bolometric luminosity, observed outside the earth's atmosphere (Hubble and Tolman, equation 4).

My purpose in re-stating here these two important formulæ due to Tolman is to make the following remarks. Both l and E_0 refer to the moment of emission, which is different for two nebulæ observed simultaneously. Should l and E_0 exhibit a general dependence on R, then it would no longer be reasonable to regard them as *constants*, when equations (1) and (2) are combined (as they actually are) with the hypothesis of uniform spatial distribution of the nebulæ. For the latter, if admitted at all, has to apply to nebulæ which are intrinsically similar at the *same* moment of time—not at such moments as depend on the accidental position of our galaxy.

As regards l, the question is, whether we are inclined to assume (*a*) that the distances between the stars within a nebula behave, on the average, like the distances between two points of a rigid body—say, the ends of the Paris metre rod; or (*b*) like the distance between two distant nebulæ. Clearly the case of the stars is intermediate. To regard l as a constant means to decide for the first alternative. The second one would make l/R constant, giving formula (1) the same form as in the case of a non-recessional explanation of the red-shift (see Hubble and Tolman, equation 3′).

As regards E_0, the possible general decline of the nebular candle-powers has already been mentioned by Hubble and Tolman (see their concluding remarks). To the assumption that the same amount of energy is emitted during every second, there is a peculiarly simple alternative, namely, that the amounts of energy, which *have* been emitted during a second, *remain* equal. On account of the decay of travelling energy, this assumption would mean $E_0 \sim 1/R$, which reduces equation 2 to the same form as in the case of a non-recessional explanation of the red-shift (see Hubble and Tolman, equation 4′). I do not mean to suggest $E \sim 1/R$ particularly. I mention it in the way of an example.

These remarks detract nothing from the importance of deciding by observation how $d\theta$ and ρ actually behave, if the photographs are interpreted as assuming uniform spatial distribution. I understand that present evidence points to observed luminosities (ρ) decreasing with distance *not even quite as rapidly* as we should expect (with E_0 = const.) from the non-recessional explanation. If that is so, I should say they rather support the recessional explanation, in spite of its predicting a still more rapid decrease of the ρ's. The discrepancy, though greater, can here be removed by assuming the E_0's to decrease with time; an assumption which is very plausible in an expanding universe, which, on the whole, cools down; but not at all plausible in a static one.

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July 31.

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The Forbidden $^3P_0$–$^1D_2$ Line of O III in the Nebular Spectrum of Nova Herculis 1934

ALTHOUGH the two well-known lines of [O III] $\lambda = 5007$ A. ($^3P_2$—$^1D_2$) and $\lambda = 4959$ A. ($^3P_1$—$^1D_2$) are the most prominent features in the spectra of planetary nebulæ and novæ at the nebular stage, the third line of the triplet, corresponding to the $^3P_0$—$^1D_2$

transition, for which the calculated wave-length is $\lambda = 4931{\cdot}8$ A., has not been generally observed. Recently, however, Bowen and Wyse[1] attributed to the $^3P_0 - {}^1D_2$ transition the faint line which they observed in the spectra of the nebulæ *N.G.C.* 7027 and *N.G.C.* 6572.

In the nebular spectrum of Nova Herculis 1934, we have also observed, in 1935 and 1936, a rather faint but well-defined radiation $\lambda = 4932$ A.[2], but could not find to what it could be attributed. Measurements of our fourteen best plates give the wave-length

$$\lambda = 4932{\cdot}2 \pm 0{\cdot}6 \text{ A.},$$

which agrees well with the predicted wave-length for the third [O III] line. This line has been observed neither by Beer nor by Adams and Joy; but in McLaughlin's table[3] concerning the nebular spectrum of Nova Herculis we find a faint radiation $\lambda = 4932{\cdot}5$ without identification.

Though the intensity of the two lines $\lambda = 5007$ and $\lambda = 4959$ A. has much decreased since 1936, the line $\lambda = 4932$ A. is found again in some plates taken at the Observatory of Lyons during the year 1938. It is perhaps not impossible that the $^3P_0 - {}^1D_2$ line is now blended with the faint line $\lambda = 4933$ A. of *N V* (6*D*–7*F*); but this line was certainly not present at the beginning of the nebular stage. Thus the attribution of the line $\lambda = 4932$ A. to the forbidden transition of O III seems to be not doubtful.

We shall naturally expect to find the same line in nebular spectra of other novæ. On August 8 and 13, 1918, Wyse[4] observed a faint unidentified radiation at $\lambda = 4933{\cdot}3$ and $\lambda = 4932{\cdot}4$ A., in the nebular spectrum of Nova Aquilæ 1918.

According to Condon[5], the transition probability for the $^3P_0 - {}^1D_2$ transition has theoretically a zero value, but in a recent paper Pasternak[6] gives a small but non-zero value. The transition probabilities calculated by Pasternak are indeed:

$$\begin{array}{ll} ^3P_2 - {}^1D_2 & 0{\cdot}016 \text{ sec.}^{-1} \\ ^3P_1 - {}^1D_2 & 0{\cdot}0055 \\ ^3P_0 - {}^1D_2 & 1{\cdot}3 \times 10^{-6}. \end{array}$$

Roughly speaking, the $^3P_0 - {}^1D_2$ transition should be four thousand times less probable than the $^3P_1 - {}^1D_2$ transition. It is impossible to say, without any photometric measurements, whether the observed intensity ratio is or is not in agreement with the predicted value. It seems, however, difficult to admit that the observed line $\lambda = 4932$ A. is four thousand times less intense than the line $\lambda = 4959$ A. The $^3P_2 - {}^1D_2$ and $^3P_1 - {}^1D_2$ transitions are due to magnetic dipole radiation, and, according to Pasternak, the probability transitions should be accurate in absolute value to within 25 per cent; on the contrary, the $^3P_0 - {}^1D_2$ transition is due to electric quadripole radiation and the corresponding probability transition should be good only to within a factor of two.

J. DUFAY.
M. BLOCH.

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August 3.

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[3] *Public. Obs. Michigan*, **6**, 201 (1936).
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[6] *Public. Astro. Soc. Pacific*, **51**, 160 (1939).

Influence of Temperature on the Pressure Broadening of Spectral Lines

IN a former note[1] we reported the results of our researches on the influence of temperature on the broadening of the mercury absorption line 2537 A. caused by helium at constant concentration of both gases. No changes of the line width exceeding the limits of experimental errors were observed. Now we have investigated with the same experimental arrangement the broadening of this line caused by admixture of argon. The constant concentration of mercury was about 6×10^{14} atoms per c.c. and that of argon $1{\cdot}4 \times 10^{18}$ atoms per c.c.

Nearly all absorption spectra obtained show a slight increase of the area limited by the line contour, that is, an increase of the width of the broadened line with the temperature. The increase of area due to the temperature change from 420° K. to 1300° K. was found not to exceed 10 per cent (for different plates this effect varies from −2·3 per cent to 10 per cent, the mean value being 3·6 per cent). This experimental increase does not reach the values calculated on the basis of theories of Lorentz[2] (36 per cent) or even of Weisskopf[3] (18 per cent). Also, as is well known[4,5], the asymmetrical intensity distribution within the mercury line 2537 A., broadened by argon, does not agree with the dispersion distribution given by the above-mentioned theories.

We have observed also another temperature effect, namely, the diminution of asymmetry of the line at higher temperature. Although the temperature influence seems really to exist in this case, both these effects are too small for the exact quantitative investigation with our present experimental arrangements.

It should be mentioned that besides the paper of Orthmann (quoted in our first note) whose results agreed with the Lorentz theory, the same problem has been experimentally investigated also by Hull[6]. The temperature effect on the pressure broadening of the potassium resonance line by nitrogen found by the latter amounts to 1630 per cent of that predicted by Lorentz's theory and 2790 per cent of that predicted by the Weisskopf's theory. Thus these results show even more pronounced discrepancy with the collision damping theories than ours, although their deviation is in the opposite direction to that found by us.

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2nd Physical Institute,
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Aug. 18.

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Effect of an Excitation Energy on the Specific Heat of Liquid Helium II and its Relation to the Exchange Effect in a Non-Ideal Bose-Einstein Gas

IT has been suggested that, for the explanation of the abnormal properties of liquid helium II, a division of the molecules into molecules 'at rest' and 'moving' ones is an essential feature[1,2,3]. The free path for collision between molecules of different systems should be very large.

London[4] has directed attention to the fact that an ideal Bose-Einstein gas shows a transition point, which lies at 3·15° K. for a gas of a density and a molecular weight of liquid helium. Moreover, below this transition point the gas allows also a division of the molecules in those condensed in the lowest energy state, and others having a kinetic energy.

However, it can scarcely be expected that the velocity distribution of the moving particles in liquid helium can be identified with that of an ideal Bose-Einstein gas, so that it is not surprising that the specific heat of such an ideal gas[4] does not agree with that of liquid helium. The specific heat should increase $T^{3/2}$, whereas experiments show an increase with, at least, T^3.[5]

This difficulty can be eliminated by the assumption of an 'excitation-energy', which must be added to a condensed particle before it can participate in the velocity distribution of the moving ones. The specific heat increases then exponentially at low temperatures. In this way a better representation of the anomaly in the specific heat is obtained.

The existence of such an 'excitation-energy' can be explained on similar lines as the disorder energy in Fröhlich's theory of liquid helium[6]. On the other hand, it may also be derived from the gas model, as a consequence of the theory of a non-ideal Bose-Einstein gas below its transition temperature.

Here the excitation energy is due to the effect of exchange, which gives rise to a different interaction when molecules are in the same and when they are in different states. This effect leads to important corrections in the specific heat below the transition temperature, as then many particles will occupy the same, namely, the 'condensed' state.

A more detailed discussion will be published in *Physica*.

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July 31.

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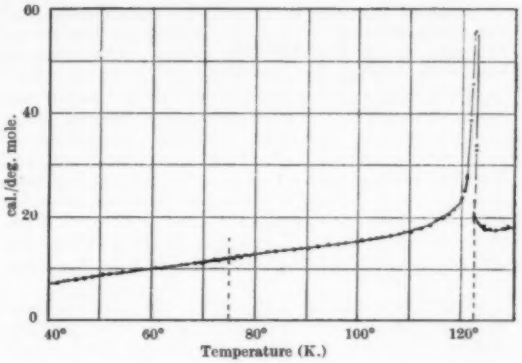
Specific Heat of a Substance showing Spontaneous Electric Polarization

VARIOUS authors[1] have investigated the specific heat of Rochelle salt, the best-known example of substances showing spontaneous electric polarization, but the results obtained so far have been somewhat contradictory. In some of the experiments a small anomaly at the Curie point (the upper limit of the Rochelle electric temperature region) was observed. Very little is, however, known about any thermal effects at the lower limit of the Rochelle-electric region. This temperature has sometimes been called the 'lower Curie point', and it has been suggested[2] that it should be marked by an anomaly in the specific heat.

We have now determined the specific heat of potassium dihydrogen phosphate which shows Rochelle electricity in the temperature region between 75° and 122° K[3]. The result of this investigation is given in the accompanying graph. It is evident from our measurements that there is no trace of any anomaly at the 'lower Curie point'. This means probably that the apparent disappearance of spontaneous electric polarization towards lower temperatures is due to a 'freezing-in' of the dipoles; that is, their inability to orientate themselves below a certain temperature owing to lack of thermal motion in the lattice. It seems, therefore, misleading to describe this temperature as a 'lower Curie point'.



A strong anomaly was observed at the Curie point (122° K.). Owing to the very gradual rise of the specific heat at the onset of this anomaly, an accurate evaluation of its energy content seems difficult. While these experiments were in progress, measurements of the specific heat at the Curie point were reported by Bantle and Scherrer[4] and Stephenson and Hooley[5]. Whereas our values in this temperature region agree well with the results of the latter authors, they differ considerably from those of Bantle and Scherrer. These authors observe the anomaly at 114° K. and give much higher values for the specific heat.

A full report of our experiments will be published elsewhere.

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August 18.

Kobeko and Nelidow, *Sowj. Phys.*, **1**, 382 (1932). Rusterholz, *Helv. phys. Acta*, **8**, 39 (1935). Wilson, *Phys. Rev.*, **54**, 1103 (1938). Hicks and Hooley, *J. Amer. Chem. Soc.*, **60**, 2994 (1938).
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A Particular Mode of Fission of the Uranium Nucleus

As has been reported by one of us[1], uranium fission products can be collected by the recoil method many hours after the end of the irradiation of uranium by slow neutrons. This phenomenon can be explained in the simplest way by the assumption that one or more of the fission products are radioactive gases, of more or less long life and coming somewhere in the middle of the β-transmutation chain. To test this assumption we have performed the following experiments.

About 20 gm. of sodium pyrouranate placed in a glass tube between two cotton-wool plugs was irradiated by slow neutrons from a radio-thorium

plus beryllium source equivalent to about 400 millicuries radon plus beryllium during seventeen days. One hour forty minutes after the irradiation had been interrupted, the glass tube with sodium pyrouranate was connected to a water pump and a stream of pure air (radon-free) was passed through it during 50 minutes to remove any radium emanation and the gaseous products of fission, which might have been accumulated in the uranium. Then a glass tube with pure silica-gel cooled to the temperature — 110°C. was placed between the tube with pyrouranate and the water pump and a stream of pure air was passed through the system for four hours. The silica-gel was then treated by hot dilute (1 : 5) hydrochloric acid to which some barium, strontium and lanthanum salts were added. The solution was filtered under suction and a complete chemical separation of lanthanum, barium and strontium was performed. The lanthanum, barium and strontium precipitates were found to be radioactive and showed the following half-life periods: La + K, $T \sim 30$ m., $T \sim 9$h. 30m., and $T \sim 45$h.; Sr, $T \sim 20$m., $T \sim 7$h. 30m. and one isotope of much longer period; and Ba, $T \sim 10$h. and $T \sim 50$h.

To find out whether the gaseous radio-elements are in the middle or at the beginning of the transmutation chain, we have separated the fission products of uranium from uranium oxide irradiated for 36 hours by slow neutrons from a cyclotron. The intensity of the neutron beam was equivalent to about 30 curies of radon plus beryllium. We were able to collect, from the walls of the vessel in which that preparation was contained, the products of transformation of the gaseous radio-elements.

These two experiments show definitely that there exist two new fission processes of uranium under bombardment by slow neutrons, with radioactive isotopes of krypton and xenon as intermediary products of the fission, coming in the middle of the transmutation chain[3].

Further experiments will be made in order to estimate the half-life period of these new radioactive isotopes of krypton and xenon and to search for the beginning of these transmutation chains.

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Academy of Science of the U.S.S.R.,
Leningrad.
July 21.

Wolkov, N. F., *C.R. Acad. Sci. URSS.* (in the press).
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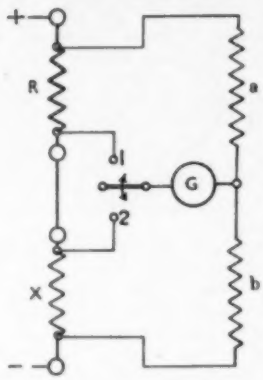
Comparison of Resistances of Four Terminal Resistors

THE only precise method given in the standard text-books for the comparison of the resistances of four terminal resistors is the Kelvin double bridge, and it appears to be the only one used for this purpose. The method described below is at least as precise and should, in my opinion, be as well known.

The circuit is shown in the accompanying figure, in which R and X are the standard and unknown resistances respectively; a is a fixed resistance, conveniently one of the ratio arms of a standard bridge and b is the variable arm of the bridge.

With the switch on contact 1 a balance is obtained and a second balance with the switch on contact 2. If the values of b for the balances are b and b'



respectively and r is the resistance between the inner potential terminals, we may write:

$$R.b = a(X + r) \text{ and } b'(R + r) = X.a.$$

Hence

$$\frac{R}{X} = \frac{a(a + b')}{b'(b + a)}.$$

This method has the following advantages over the double bridge, (1) less apparatus is required, (2) the effective sensitivity of the galvanometer is greater, and (3) no current passes, at balance, through two of the four potential terminals.

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August 4.

Inactivation of Diethylstilbœstrol in the Organism

IN previous reports[1] it has been demonstrated that the sex hormones (œstrone, progesterone) are rapidly rendered inactive in the organism. If a rat is injected with 1,000 I.U. œstrone no more than 1–2 per cent of this substance can be recovered from the organism by organic solvents after a period of forty-eight hours. In contradistinction to this, the hormone esters (œstronebenzoate, œstradiolbenzoate) are very largely recovered. These findings have been corroborated by Laqueur[2], who was able to demonstrate at the same time that the hormone esters remained deposited at the site of injection. They do not undergo slow decomposition in the blood, but are slowly absorbed from the site of injection.

We proceeded to investigate the behaviour of 4 : 4′-dihydroxy α-β-diethylstilbene (diethylstilbœstrol) which was described by Dodds, Golberg, Lawson and Robinson in 1938[3]. The authors, in a most instructive descriptive sketch, demonstrated the resemblance between these œstrogenic substances and œstradiol. Hence we compared the inactivation of stilbœstrol with that of œstradiolbenzoate and some other œstrogens.

Infantile rats were injected with 1,000 I.U. of œstrogenic substance dissolved in 0·1 c.c. of oil. After forty-eight hours the animals were killed and an attempt was made to recover the œstrogenic hormone from the whole body of the animal by

my method[1], especially devised for this purpose. The hormone yield is seen in Table 1.

TABLE 1.

Œstrogenic substance	In the body	In the excreta
Œstrone	1-2 per cent	0 per cent
Œstrone benzoate ..	80 ,, ,,	Not examined
Œstradiolbenzoate ..	40 ,, ,,	1 per cent
Œstrone methyl ether[4]	70 ,, ,,	5 ,, ,,
Stilbœstrol	25 ,, ,,	25 ,, ,,

These experiments show that roughly 50 per cent of stilbœstrol can be recovered and that, in this respect, it resembles the hormone esters. It differs from those substances, however, in that half the amount is eliminated in the excreta.

We further investigated the question whether the slow decomposition in the organism is due to storage at the site of injection, or whether the substances are subject to slow decomposition during their circulation in the body. We injected stilbœstrol and other œstrogenic substances (1,000 I.U. in 0·1 c.c. of oil) into the hind-leg of infantile rats, killing the animals after forty-eight hours, and extracted separately the anterior and posterior half (without viscera). The result was that stilbœstrol was exclusively found in that part which contained the site of injection (Table 2).

TABLE 2.

Œstrogenic substance	Anterior half	Posterior half
Œstradiolbenzoate ..	0	40 per cent
Œstrone methyl ether	0	70 ,, ,,
Stilbœstrol	0	25 ,, ,,

The experiments lead tothe fo llowing conclusions :

(1) In contrast to œstrone, stilbœstrol is only rendered inactive in the organism to a small extent, resembling, in this respect, the hormone esters.

(2) Similarly to the hormone esters, stilbœstrol remains deposited at the site of injection for a considerable time (depot formation) and from there it is slowly absorbed.

(3) Stilbœstrol is distinguished from the hormone esters by the fact that large amounts are eliminated in the excreta, particularly in the urine.

While after absorption the hormone esters are rapidly rendered inactive in the organism, this is not the case with stilbœstrol. In the excreta large amounts of the active substance are found. The fact that the organism is unable to inactivate considerable amounts of stilbœstrol probably helps to explain its eventual toxic activity (compared with œstrone) particularly if large doses are used.

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Jerusalem. August 19.

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Estimation and Occurrence of Keto-Acids in Green Plants

ACCORDING to the present conception the keto-acids occupy a central position in the synthesis of amino-acids. Attention has been paid especially to the 'fundamental keto-acids', namely, oxaloacetic acid and keto-glutaric acid, since the amino group of aspartic and glutamic acids formed from them is transferred to other keto acids. In green plants, however, keto-acids other than oxaloacetic acid—the presence of which in the growing legumes has recently been demonstrated in this laboratory[1]—have hitherto not been found, evidently due to the absence of suitable methods.

Lately we have developed the following technique for the determination of keto-acids in plants.

Caustic soda solution and fine quartz sand are added to plant material[1]. The mass is crushed in a mortar and 2-4-dinitrophenylhydrazine solution, strongly acidified with hydrochloric acid, is added to it. The mixture, the *p*H of which is less than 1, is allowed to stand for one hour at room temperature, whereupon anhydrous sodium sulphate is added until the mass is dry. The mass is extracted with ether in the Soxhlet apparatus. The ether solution, which contains the dinitrophenylhydrazones formed, is shaken with sodium carbonate solution. The solution is then made acid with hydrochloric acid and the hydrazones are again precipitated from it by allowing the solution to stand for three days in the ice-box. The precipitate is separated, dissolved in alcohol and hydrated according to Tafel[2] but at near to 0° C. with sodium amalgam. Amalgam must be added in small quantities to the reaction solution. Thereby the hydrazones are decomposed so that the keto-acids form the corresponding amino-acids as a reduction product. Alcohol is distilled away *in vacuo* and the rest is dissolved in water. The amino-acids formed are determined in the solution. By means of the method in its present form, 80–90 per cent of the keto-acids are found.

In the above manner we have succeeded in finding and determining oxaloacetic acid, keto-glutaric acid and pyruvic acid in growing peas and red clover. For instance, in an experiment with red clover there were found 42 γ keto-glutaric acid, 18 γ oxaloacetic acid and 12 γ pyruvic acid per one gram of fresh material. Investigations are being continued also with non-legumes. The method is applicable also to the determination of keto-acids in animal material and micro-organisms.

A detailed account of the experiments will be given in the *Biochemical Journal*.

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Biochemical Institute,
Helsinki. August 16. HEIKKI SUOMALAINEN.

[1] Virtanen and Arhimo, NATURE, **144**, 36 (1939).
[2] Tafel, *Ber. deutsch. chem. Ges.*, **19**, 1924 (1886).

Effect of Ethylene on *Mangifera indica*

THE variations in the chemical changes of the respirable substrate accompanying the process of fruit development and ripening of the different varieties of the tropical fruit *Mangifera indica* were investigated with the view of finding out the nature and the response of the substrate to the different methods of storage. Such investigations would provide helpful information for devising methods of storage of this delicate and easily perishable fruit. Accordingly, investigations as to the changes in the respirable substrate under the different conditions of storage were planned and carried out, first at a lower temperature of 8–12° C., secondly in ordinary room conditions of 28–32° C., and thirdly the effect was examined of different concentrations of ethylene gas as a means of artificial ripening.

The presence of ethylene gas is detected in developing *Mangifera indica* by stunted growth of pea

seedlings in an atmosphere produced by ripening mangoes. The effect of ethylene on pears by Hansen[1,2], on lemons by Denny[3], on bananas by Wolfe[4], and on tomatoes by Work[5] has been studied; but the chemical changes brought about in the metabolites of the fruit have not yet been clearly understood. Hansen and collaborators have found the effect of ethylene on pears to be more marked at a certain period of the maturity of the fruit and found that the rate of respiration, the rate of starch hydrolysis and the concentration of the total and reducing sugars increased.

In *Mangifera indica* we found that the effect of ethylene is more marked in the pre-climacteric phase of the fruit, and in the post-climacteric phase the effect is not pronounced. This effect is marked by a very rapid increase in the respiration rate, by strong hydrolysis of starch and increase in total and reducing sugars and decrease in titratable acidity and alcohol insoluble residue.

Some of the results showing the amount of respirable substrate obtained at the end of a period of nine days experiment from various samples of different treatments (calculated on the basis of original substrate concentration as 100) are given in the accompanying table:

Substrate	Original substrate concentration	At the end of a period of 9 days			
		Untreated (control)	Ethylene treated 0·1%	Ethylene treated 1·0%	Cold storage
1. Starch ..	100	36·69	10·49	26·29	56·86
2. Total sugar ..	100	443·90	775·70	612·10	302·80
3. Reducing sugar	100	325·00	491·60	416·60	385·83
4. Titratable acidity (expressed as citric acid)	100	55·50	17·50	17·50	94·06
5. Alcohol insoluble residue ..	100	42·17	27·03	37·84	77·30

In cold storage the trend of chemical changes is in the same direction, but the process is appreciably slowed down. The respiration rate increases markedly in ethylene treated fruit. The vitamin C content decreases as the fruit ripens and it decreases also in storage. The effect of ethylene on vitamin content is not yet clear and work on other tropical fruits is in progress. The effect of ethylene seems therefore to be of a respiratory nature. It initiates a chain of chemical reactions in the available substrate of the fruit, and the effect of ethylene reaction is in turn dependent on the nature of the substrate provided according to the stage of the maturity of the fruit.

Detailed results of these investigations are in course of publication in the *Transactions of the Bose Research Institute*.

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July 13.

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Neural Mechanism of Sexual Behaviour in the Female Cat

FEMALE cats in spontaneous or induced œstrus display a characteristic behaviour which may be divided into: (1) courtship activities (playful rolling, rubbing, calling, crouching with pelvis raised, and 'treading'), and (2) the after-reaction (vigorous or frantic rolling, rubbing, squirming, and licking).[1] Bard[1] has shown that extirpation of the neocortex does not change the specific pattern of the sexual response. It was my aim to determine if this peculiar performance of the female cat during 'heat' is conditioned by the activity of an encephalic 'sexual centre' or if some typical components of the complex behaviour could still be elicited from the spinal cord after transection of the brain stem below the medulla.

It is self-evident that, among the reactions mentioned above, only those the accomplishment of which is not dependent on the integrating mechanism of standing and equilibrium are suitable for this kind of experiment. Two reflexes fulfil these conditions: raising of the pelvis, and 'treading'. Treading consists in a rhythmic slow or rapid marching movement of the hind legs with flexion of the thigh and knee and dorsal flexion of the foot, as soldiers mark time. This is obtained by gentle tapping of the perineum. During the course of the investigation another reflex apparently characteristic of 'heat' was observed: when the perineum is tapped on one side the tail is swept towards the other and maintained there until the stimulus ceases, uncovering the whole perineum. This is the natural attitude of the female cat in œstrus when approached by a male. These three reflexes were used as tests for 'heat' in the spinal cats.

The investigation was carried out on thirteen cats, eight of which were normal, in the beginning or towards the middle of their breeding season. Five were ovariectomized during the breeding season and studied towards the end or after the same. In all the spinal cord was transected at the level of the first cervical segment, artificial respiration applied, and the cat kept warm on a heating pad. From three to six hours after the transection, when the spinal shock had subsided, the sexual reflexes were tested on the animal held in crouching position, hindlegs flexed, chest touching the table. Of the eight normal cats, all but one showed a complete positive response to tapping of the perineum. Vaginal smears and the condition of the ovaries indicated œstrus, pro-œstrus or metœstrus. The one negative result was obtained on an old female with anœstrus smear and smooth ovaries. She showed as the only response an elevation of the pelvis. Of the five animals ovariectomized three months previously, three were not injected with œstradiol. Their response was negative as regards treading and tail movements. Two of them showed some raising of the pelvis. When tested before the transection no response whatever could be elicited. The other two ovariectomized animals were injected twice during six days with 1 mgm. œstradiol (Schering Progynon *B* 1939); when they exhibited typical sexual behaviour the transection was made. Reflexes similar to those obtained from the normal cats on heat were obtained from them.

These experiments demonstrate that some components at least of the sexual behaviour are short arc reflexes, comparable to the scratch-reflex, which can be elicited independently of the higher centres, but the occurrence of which depends strictly on

hormonal conditions. It seems, therefore, that the existence of a hypothetical 'sexual centre'[2] should be accepted with caution, and then not so much as a pace-maker under the influence of which unspecific activities of the spinal cord are transformed into specific sexual reactions, than as a mechanism co-ordinating certain independent activities pre-existing at different levels of the brain stem. Dempsey and Rioch's[3] failure to obtain sexual reflexes from decerebrate cats may be explained by the extensor rigidity which follows the mesencephalic transection, rhythmic reactions (as treading) and reflex raising of the pelvis requiring for their performance a normal balance of muscle tone.

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[1] Bard, Ph., *Psych. Rev.*, **41**, 424 (1934); *Amer. J. Physiol.*, **116**, 4 (1936).
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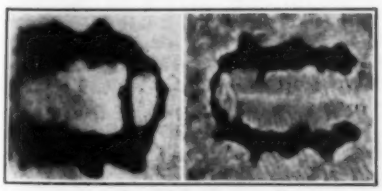
Abnormal Mitosis in Tobacco Plants Forming Hereditary Tumours

TOBACCO species hybrids *Nicotiana glauca* ($n=12$) × *N. Langsdorffii* ($n=9$), *N. paniculata* ($n=12$) × *N. Langsdorffii*, *N. suaveolens* ($n=16$) × *N. Langsdorffii*, etc., formed hereditary tumours[1-3] all over the plants when they were as old as 4–7 months. Each plant of the amphidiploid *N. glauca* × *N. Langsdorffii* (=*N. Vavilovii*; $n=21$) also formed hereditary tumours at about the same age. In searching for the cause or causes of tumour formation[4-5] I also examined the frequency of the abnormal mitosis in longitudinal sections of root tips of old *N. Vavilovii* plants. I counted normal late anaphases and late anaphases with chromatin bridges and obtained the following figures in studying 752 cells of five different plants which formed hereditary tumours: 21·4, 12·2, 10·7, 8 and 4·2 per cent anaphases with at least one chromatin bridge. 264 anaphases of the maternal plant *N. glauca* and 232 anaphases of the paternal plant *N. Langsdorffii* were also studied. No chromatin bridge was found in these anaphases.



ANAPHASES WITH CHROMATIN BRIDGES FOUND IN THE AMPHIDIPLOID *N. glauca*-*Langsdorffii* PLANTS THAT FORMED TUMOURS.

Abnormal mitosis, and in particular the formation of chromatin bridges, found in the amphidiploid *N. Vavilovii* does not seem to be due to its polyploid nature, because in studying 72 anaphases of the autotetraploid *N. glauca* no chromatin bridges were found.

The procedure of mitosis in the amphidiploid *N. rustica* ($n=24$) × *N. glauca* (=*N. rugla*; $n=36$) was also studied. (This amphidiploid does not form hereditary tumours.) In studying 116 late anaphases of one plant of this amphidiploid I found in four of them chromatin bridges, that is, in 3·4 per cent of the cells. This is a somewhat lower percentage than (though very close to) the smallest one found in the fifth tumour-forming plant; but still high enough when compared with that of the normal species (0 per cent). Tumour-forming plants, however, have on the average a considerably higher percentage of abnormal mitosis. Chromatin bridges represent bicentric chromosomes, resulting, most probably, from exchange of parts between non-homologous chromosomes.

A causal interpretation of tumour formation in the light of these studies can be advanced in the following way. Daughter cells resulting from cells with abnormal mitosis in general and from such with chromatin bridges in particular should have abnormal genetic constitutions. Although such cells may have a lower rate of cell division, their number should be gradually increased, because the process is irreversible, so that the older the plant is the greater percentage of cells with abnormal genetic constitution it should have. When the percentage of the cells with abnormal genetic constitution is considerably increased, determination and differentiation processes become abnormal, so that the plants form tumours (meristematic and parenchymatic tissues) instead of normally differentiated shoots and organs. The formation of abnormal shoots ('bud mutations') in about 12–18 per cent of the plants in some lines of *N. Vavilovii* is also conditioned by abnormal mitosis.

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[1] Kostoff, D., *Zentralbl. Bakter.* (II) **81**, 244–260 (1930).
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[3] Kostoff, D., *J. Genet.*, **37**, 129–209 (1938).
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A 'Safe' Fluid for Museum Use

THE general practice of using ethyl alcohol as a preservative fluid for museum specimens has several disadvantages. At the present time when we are faced with the possibility of high explosives and incendiary bombs damaging museums, the inflammability of alcohol naturally causes much concern to the staff of such institutions. Ten years ago[1] I directed attention to a preservative fluid, first used by W. Pampel[2], for storing specimens of insects for several years with the tissues soft and in good condition for subsequent dissection. I gave this medium the name of 'Pampel's fluid' and its composition is as follows:

Glacial acetic acid	4 parts
Distilled water	30 parts
Formaldehyde	6 parts
95 per cent alcohol	15 parts

For several years past I have abandoned the use of alcohol for preserving insects and many other arthropods in favour of Pampel's fluid. This fluid is in every way superior to ethyl alcohol, being cheaper, does not need replacement so often and does not cause undue hardening, besides preserving

the tissues in a better condition. It is, furthermore, non-inflammable.

I have advocated its use to a number of zoologists and others, and may add that one recent biological expedition preserved almost all its specimens in Pampel's fluid with complete success. It has the drawback that in the case of vertebrates, echinoderms and many of the higher crustaceans, the acetic acid naturally acts upon the calcareous skeleton; but for the vast majority of invertebrate animals this disadvantage does not arise. I recommend that a beginning be made in the use of this fluid with as little delay as possible. Many alcohol-preserved specimens can be transferred into it and it can be adopted for new specimens that it is desired to preserve. It should, at least, be given an adequate trial for a few years.

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[1] *Bull. Entom. Res.*, **20**, 169 (1929).
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The Ancestors of the Eutheria

IN a short article on the ancestors of the Eutheria, published in NATURE of September 16, p. 523, Dr. Abbie lays considerable stress on a novel interpretation of the phylogenetic history of the corpus callosum of the brain. Dismissing the generally accepted interpretation, based on the classical studies of the late Sir Grafton Elliot Smith, he states "it has been shown that in reality the corpus callosum has appeared in quite a different manner". For his evidence Dr. Abbie relies on certain topographical observations which he has published in the *Journal of Comparative Neurology* (**70**, 9; 1939). Whether Dr. Abbie's interpretation is correct or not, it should be pointed out that his evidence appears inconclusive to several other comparative neurologists. Indeed, in a forthcoming paper by Prof. F. Goldby, to be published in the *Journal of Anatomy*, Dr. Abbie's views on the evolution of the corpus callosum are subjected to serious criticism.

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Points from Foregoing Letters

E. Schrödinger directs attention to the fact that in an expanding universe (*a*) the diameters of the nebulæ, (*b*) their intrinsic luminosities, may quite reasonably be assumed to depend on the state of expansion. If it is true that their observed luminosities decrease with increasing distance a little too slowly even for the non-recessional explanation of the red-shift, then the recessional one has to be preferred anyhow. For though the discrepancy here becomes greater, a plausible assumption as regards (*b*) will easily remove it.

The forbidden $^3P_0 - {}^1D_2$ line of O III, the transition probability of which has a small but non-zero value, has been recently identified in the spectra of two nebulæ. J. Dufay and Miss M. Bloch attribute to this transition the rather faint but well defined radiation $\lambda = 4932{\cdot}2$ A. which they have observed in the nebular spectrum of Nova Herculis.

H. Horodniczy and A. Jabłoński find that the influence of temperature on the width of the mercury absorption line 2537 A. broadened by argon is smaller than that predicted by the theories of Lorentz and Weisskopf. However, a small temperature effect seems to exist; increase of temperature causes a slight increase of the width and diminution of the asymmetry of the line.

J. and K. Mendelssohn have measured the specific heat of potassium dihydrogen phosphate between 40° and 130° K. No anomaly occurs at the so-called 'lower Curie point', and it is concluded that at this temperature the mobility of the dipoles freezes-in. A strong anomaly occurs at the upper Curie point.

Two sets of experiments on the disintegration of uranium by slow neutrons have been carried out by W. G. Chlopin, M. A. Passwik-Chlopin and N. F. Wolkov. In one set, a uranium salt was exposed to slow neutrons for seventeen days, and the products separated by chemical means; in the other, the exposure was 36 hours and the products of transformation of the gaseous radio-elements were collected from the walls of the reaction vessel. It is claimed that radioactive isotopes of krypton and xenon are formed as intermediate products in the fission of uranium by slow neutrons.

A single bridge method for comparing the resistances of two resistors of low ohmic value is described by A. Glynne. Two balances are effected and the formula for calculating the ratio of the resistances is given.

By experimenting with infantile rats, B. Zondek and F. Sulman have shown that stilbœstrol is only rendered slightly inactive in the organism. Thus it differs from œstrone, but resembles the hormone esters. Also like the latter, stilbœstrol remains at the site of injection for some considerable time and is then slowly absorbed. Unlike hormone esters, stilbœstrol is eliminated in large quantities in the excreta.

A. I. Virtanen, A. A. Arhimo and H. Suomalainen describe a method for determination of keto-acids in plants. The method is based on the formation of 2-4-dinitrophenylhydrazone and its reduction with sodium amalgam in alcohol solution to amino-acids corresponding to the keto-acids. In this way keto-glutaric acid, oxaloacetic acid and pyruvic acid have been determined in plants.

B. K. Kar and H. N. Banerjee have found that the effect of different concentrations of ethylene gas on *Mangifera indica* is more pronounced in the pre-climacteric stage of the developing fruit than in the post-climacteric phase. The effect is seen in the rapid increase of the respiration rate, strong hydrolysis of starch, increased concentration of total and reducing sugars and decrease in titratable acidity and alcohol-insoluble residue. The action of ethylene seems to be of a respiratory nature, and is dependent upon the available substrate, which depends on the stage of the maturity of the fruit.

According to J. P. Maes, sexual behaviour can still be obtained from the spinal cord of female cats in heat when all connexions with encephalic centres have been severed.

RESEARCH ITEMS

Northern Paiute Bands

THE Northern Paiute, once occupying parts of Nevada, Idaho, Oregon and California, belong to the Mono-Paviots dialect of the Plateau Shoshonean language. Although almost everyone writing about these Indians has testified to the existence of bands among them, no one has troubled to ascertain systematically their number, names, or territorial extent. So long ago as 1870, the difficulty of dealing with the Paiutes was recognized by the authorities of the United States as due to the fact that they had no tribal organization, but were divided up into bands of from 50 to 200, each under the nominal leadership of individuals elected by themselves, each band acting independently, although they recognized that they were linguistically and culturally related, and considered themselves as all members of one tribe. The basic unity of the Northern Paiute appears from the fact that they pictured exact boundaries dividing themselves from surrounding tribes, whereas interband divisions were often vague and indefinite. Band territories consisted of a relatively productive area and its environs. In spite of some laxness, the bands had recognized possession of certain tracts, piñon ranges, lakes, streams and hunting grounds. If other Paiutes obtained food there, it was understood that they did so as visitors. Claimed lands seldom overlapped, except where two adjacent bands recognized mutual use of a district. Bands in arid areas travelled more, and spent several months each year as visitors of their friends living in more productive areas. Detailed information concerning each one of the twenty-one bands of the Northern Paiute has been collected in field work and from the literature by Omer C. Stewart (Univ. California: *Anthropological Records*, **2**: 3, 1939) from which has emerged much evidence bearing upon problems of traditional migrations and Paiute affinities.

Protobranchiate Mollusca

THE affinities of the Protobranchiate Mollusca, worked out morphologically by Pelseneer between 1891 and 1911, have now been revised by C. M. Yonge (*Phil. Trans. Roy. Soc.*, B, **230**, 79–147; 1939) as the result of a study of living members of the group. Yonge admits three families, the Nuculidæ, Solenomyidæ and Nuculanidæ, the last-named including Thiele's Malletiidæ. In his view "the order Protobranchia established by Pelseneer in 1891 is valid and . . . represents the one unquestionably natural group within the class Lamellibranchia". Yonge studied the mode of life of members of the order at Herdla, Plymouth and Naples, particularly their manner of progression, feeding habits and digestion. The specialization of the foot and its muscles for burrowing into a soft substratum indicates that in this respect they are not primitive, as Pelseneer inferred. The ctenidia are not primarily food collectors and sorters, these functions being undertaken in most by means of a pair of proboscis-like protrusions of the labial palps, which collect organic debris. Typically, the stomach has ciliated sorting and chitinous crushing regions, whence food is passed to the digestive diverticula for intracellular digestion. Yonge asserts that the Protobranchia have been derived from radula-bearing ancestors, but he produces no evidence for this view. The Nuculanidæ differ from the other two families in possessing a *posterior* inhalant current entering through siphons, coupled with a muscular pumping movement of the ctenidia for respiratory purposes. The "Malletiidæ" are Nuculanids which have become modified for life on soft mud in the deep sea. Nuculids are the most primitive Lamellibranchs.

Parasitic Cirripedes of the John Murray Expedition

K. A. Pyefinch has described the Ascothoracica (John Murray Expedition, 1933–34. Scientific Reports, 5, No. 9. British Museum (Natural History); 1939). These parasites have been recorded from a number of hosts, but in this collection they are only in Zoanthids and all belong to the genus Baccalaureus (Broch). Of these, three are new species and one is the *Baccalaureus japonicus* originally described by Broch in 1929. This latter has not previously been recorded from the Indian Ocean. As the author has pointed out previously, the validity of specific distinctions within the genus is a matter of some doubt; since the complete life-history is as yet unknown, what are now regarded as specific differences may merely be due to differences in age of the specimens examined. It is interesting to find that these parasites may themselves harbour parasites. In two cases, once in *B. japonicus* and once in *B. disparcaudatus* from the same station, specimens of a parasitic isopod were found within the cavities of the lateral mantle coils, possibly male and female. A male also occurred attached to the outer surface of the mantle lobes of *B. verrucosus*. These are believed to belong to the family Cryptoniscidæ and are probably a new genus and species, to be described in a later report.

Genetics of the Raspberry

D. LEWIS (*J. Gen.*, **38**, 367–379; 1939) describes five new genes in the raspberry. These are *s*, spineless shoots; *b*, shoots without waxy bloom; *x*, red hypocotyl; *g*, pale green leaf; and *d*, sepaloid flowers. The linkage values for genes *T*, *B*, *X* and *G* belonging to one group are *TB* 28·4, *TX* 20·0, *TG* 18·2 and *BX* 36·7. The fact that homozygous hairy plants *HH* are almost completely suppressed suggests that either the constitution *HH* is inviable or that there is a lethal linked to *H*. The occurrence of a large deficiency of recessives in another strain favours the second suggestion. In accordance with Fisher's theory, the only gene (*H*) in the raspberry which is shown to have higher selective value in the heterozygous condition is also the only gene which is polymorphic in the wild.

Triticum sphaercoccum

S. ELLERTON (*J. Gen.*, **38**, 307–323; 1939) shows that *Triticum sphaerococcum* differs from *T. vulgare* by one recessive gene *s*. The cytology of the F_1 shows that there is close homology between the chromosomes. The author considers that it is

improbable that one recessive mutation should show such diverse and complex effects, and therefore suggests that there is a deletion in *T. sphaerococcum*. The exceptionally high occurrence of speltoid mutants in the F_2 of *T. vulgare* × *T. sphaerococcum* is accounted for by the assumption that the chromosomes which carry the speltoid characters are involved in one of the reciprocal translocations which were observed in the F_1.

Leaf-Spot Disease of Spinach

SPINACH is not subject to many diseases in Great Britain but H. H. Glasscock and W. M. Ware have recorded a leaf-spotting disease caused by the fungus *Heterosporium variabile* (*Gard. Chron.*, August 5). The organism was first described by M. C. Cooke in 1877, from material collected in Welshpool, but it has not appeared again in Great Britain until the present record. Several fungi are, however, mentioned as the cause of leaf-spotting upon spinach in America, and *H. variabile* is among them. The spots are purplish brown, and have conidiophores in the centre portions; they are sufficient in number and extent to cause a serious disease. Cultures have been made of the causal organism, and its characters agree very closely with those of the original description.

A Theory of Mountain-Building

AN important development of the suggestion that convection currents in the earth's substratum may have been responsible for the formation of mountain systems has been made by David Griggs (*Amer. J. Sci.*, Sept. 1939). The theory proposed is synthesized from: (1) the original suggestions of Holmes; (2) the mathematical analyses of Pekeris, Vening Meinesz, and Hales; (3) the author's experiments on solid flow of rocks; (4) thermal experiments and calculations; and (5) a dynamically similar model which demonstrates the action of cyclic convection currents. The structures developed by these currents in the model show striking resemblances to the orogenic structures of the earth. The phases of the convection-current cycle correlate with the three dominant phases of the orogenic cycle: geosynclinal, crustal folding, uplift. The hypothesis is attractive because it seems to satisfy better than any other the three fundamental conditions required of a mountain-building mechanism: (*a*) provision of an adequate compressional force; (*b*) local provision of sufficient contraction for orogenesis; and (*c*) explanation of the intermittent nature of orogenic processes and the threefold character of the mountain-building cycle. In contrast, although thermal contraction may produce sufficient force, it does not seem capable of providing sufficient shortening of the crust to produce the Tertiary mountain systems; moreover, long-distance transmission of compressive stress through the crust to provide localized orogeny is greatly hindered by the viscous drag of the substratum on the over-riding mass. Other forces which have been invoked, such as tidal pull and the *polflucht*, are totally inadequate in magnitude to explain orogenic deformations.

Earthquakes and Crustal Structure near Japan

SEITI YAMAGUTI has recently conducted an investigation (*Bull. Earthq. Res. Inst., Tokyo*, 17, Pt. 2, 429–442; 1939) to ascertain in which part of the earth's crust near Japan earthquake foci are most frequent. In the neighbourhood of the Japan trench, using the map and bathymetric chart published by the Land Survey Department of the Imperial Japanese Army and the Hydrographic Office of the Imperial Japanese Navy respectively, together with gravity anomalies, the crustal structure was determined and checked by Wadati's seismological results. The thickness of the crust in western Japan appears to be 50 km. and in north-eastern Japan 20 km. The foci of 33 conspicuous earthquakes that occurred in the same Sanriku districts during 1923–38 when the gravity results were being obtained, were as follows: 20 per cent in the subcrustal region just beneath land, 3 per cent in the subcrustal region just beyond the Japan trench and the remainder in the crustal layer or near the boundary of the crustal layer and subcrustal regions on the western side of and about the trench. Near the Inland Sea of Japan, assuming that at a depth of 30 km. isostatic compensation is fulfilled, the configuration of the boundary between the crustal layer and subcrustal region was determined using gravity anomalies. It was then found that 5 out of 7 conspicuous earthquakes between 1923 and 1938 had their foci in the submarine area where isostatic compensation is not fulfilled, and 70 per cent of the 'rather conspicuous' earthquakes, 29 in number, were similarly situated.

Chemistry of the Coloration in Jupiter's Cloud Forms

RUPERT WILDT (*Mon. Not. Roy. Astro. Soc.*, 99, 8; June, 1939) discusses the action of metallic sodium on both gaseous and condensed ammonia, and suggests this as a possible explanation of the whole range of colours observed on Jupiter. Wildt gives a description of the features of the system sodium-ammonia by the use of the phase diagram taken from a paper by O. Ruff and J. Zedner (*Ber. deutsch. chem. Ges.*, 41, 1948; 1908) and from the data he draws the tentative conclusion that the coloration of Jupiter's belts may be identified with the brown concentrated solution of sodium formed on the ammonia clouds at temperatures above — 112° C. The absence of conspicuous belts on Saturn is easily understood because this planet has a lower temperature than Jupiter. The hypothesis does not explain the preferentially zonal distribution of the brown shades on Jupiter; specialized assumptions of a meteorological character would be necessary in this case. As the equatorial plane of the planet is in close correspondence with the orbital plane, strong seasonal variations would not exist in the general atmospheric circulation, such as are observed on the earth, and here lies a partial explanation of the distribution of Jupiter's brown shades. A difficulty arises about the small blue areas on the planet because the dilute blue solutions can exist only at temperatures higher than — 78° C., and Jupiter is usually credited with an average surface temperature of only — 140° C. It is supposed that these comparatively rare blue areas are due to the anomalous release of internal energy, a view which receives corroboration from the fact that they appear in nearly all cases during periods of great eruptive activity. A more serious difficulty presents itself when an explanation is sought for the mechanism by which metallic sodium is set free from the sodium compounds that must have been formed during the condensation of Jupiter and are now probably stored in the interior. The author leaves this matter undecided for the present.

TOWN PLANNING AND URBAN CONCENTRATION

THE admirable way in which the evacuation plans have been carried out in the present emergency should not lead us to overlook the importance, when the time comes, for considering the re-planning or further development of our cities on lines designed to minimize such disturbance or upheavals, and the problems which urban concentration presents in civil defence are further reason for attention to this question at the first opportunity. The paper in which Dr. Thomas Adams discussed some economic aspects of urban concentration before Section F (Economics) at the Dundee meeting of the British Association on the very eve of the evacuation could scarcely be surpassed as an analysis of the principles involved.

Dr. Adams pointed out that concentration of industry, economic activities and population in urban centres is essential in order to secure the economic benefits to be derived from scientific progress, and need not militate against social welfare. The advantages of concentration may, however, be impaired by excess or malformation, and in many urban centres such excessive concentration has caused intolerable congestion of traffic, impaired industrial efficiency and overcrowded building development. The most powerful force in causing urban concentration is the existence and potentialities for development of transport facilities, allied with certain favourable qualities in the natural situation, and the planning and control of these facilities are essential to prevent excess.

That New York and London and certain other cities have become too unwieldy to perform their functions efficiently is probably due to their development being artificially promoted, by political agencies and vested interests, beyond that which could occur under the normal play of economic forces. The proper way to eliminate excessive concentration is to promote recentralization on sites with competitive attractions. Even in regard to vulnerability, Dr. Adams does not advocate an excessive attempt to restrict artificially the location and distribution of industry. He argues that if a city, even of the size of London, as a piece of civic machinery, is perfectly designed to perform its functions as an industrial and distribution centre, and if the residue is diffused into compact neighbourhoods and integrated with its industrial areas so as to reduce distances between homes and workplaces, the true solution is to construct adequate defences or even to face evacuation in war time at any cost.

Dr. Adams argues that the steady flow and free movement of street traffic are essential for economic efficiency, and urban areas should be planned or replanned to provide the space required. Further, if the main transport facilities are properly planned and controlled, artificial restriction of the location and distribution of industry should scarcely be required, and provision of ample space for locomotion purposes should simultaneously meet essential requirements of air space and recreation. Economic solutions of these problems largely resolve themselves into questions of transport and land prices. The reduction of costs of transport involves the elimination of unnecessary travel, and the reduction of land prices the elimination of values based on improper or unhealthy uses of land.

The need for scientific investigation of the excess concentration as a first step for a national effort towards its control was stressed by Dr. Adams. Other research is needed to ascertain the best methods of reducing 'friction of space' between producers and consumers of goods and services, and between places of residence and places of work and recreation. Town planning should be based more on the data of the economist and less on the consideration of sentimental values.

Among the major defects in urban growth, Dr. Adams directed attention to the obstruction of the movement of street traffic and the absence of space for standing traffic, as well as to the overcrowding of facilities for passenger traffic and the resultant destruction of nervous energy. He also stressed the overcrowding of population on the land, thus preventing the inhabitants from securing adequate light, air and recreation, and the absence of room for the expansion of industrial plants, markets, etc. Such evils cannot be remedied effectively by the negative process of planning control. Dr. Adams suggested that the ratio of open space in a town for traffic, recreation and space about buildings should not be less than sixty per cent.

CONFERENCE OF LEATHER CHEMISTS

DESPITE the uncertain conditions which prevailed, the Biennial Conference of Leather Trades' Chemists was held in London during August 28–30. The Conference was preceded by a reception of members of the International Society of Leather Trades' Chemists and numerous foreign guests at the May Fair Hotel, London, on Sunday, August 27, when they were received by the president of the British Section, Mr. R. Faraday Innes.

At the opening meeting, the first Procter Memorial Lecture was delivered by Dr. W. T. Astbury, the title being "The Molecular Structure of Fibres of the Collagen Group". The presidential address given by Mr. W. R. Atkin was on the subject of "The Procter Wulson Theory of Protein Swelling in the Light of Modern Ideas of Protein Structure". Prof. P. Chambard of Lyon was elected president of the Society for 1940–41.

During the meeting, it was announced that the Fraser Muir Moffat Medal of the Foundation of Tanners' Research Laboratory of America had been awarded to Dr. Dorothy Jordan Lloyd for her outstanding work in the field of tanning chemistry, and particularly her recent book on "The Chemistry of

the Proteins". Among other papers read during the meeting were, "A New Expression for the Buffering Capacity of Solutions" by Dr. V. Kubelka (Brno), "Fatty Spue in Semi-Chrome Leather" by R. Faraday Innes (London), "Studies in Currying" by M. P. Balfe (London), "Precipitation of Natural Tannins with Calcium Hydroxide" by Vl. Němec (Brno), Conductimetric Analysis of Vegetable Tanned Leathers" by S. G. Shuttleworth (South Africa), "Formaldehyde Tannage in Relation to the Constitution of Collagen" by F. O'Flaherty (U.S.A.), "The Chemistry of Formaldehyde Tanning" by Miss W. B. Pleass and Miss J. H. Boews (London), "Reaction between Casein and Formaldehyde" by C. Robinson (London), "A Machine for Measuring the Resistance of Leather to Abrasion" by F. E. Humphreys (London), "Shoe Troubles and Leather Faults" by H. Bradley.

Before the conclusion of the Conference, the following films were shown: "The Inside Story of Lubrication", "Wattle Bark and Extract Manufacture" and "Preparation of Cod Liver Oil".

PROGRESS OF ILLUMINATION

DR. H. W. MELVILLE prepared an evening lecture for the Dundee meeting of the British Association, under the title "New Lamps for Old"

The natural illuminant, the sun, is considered first. We may regard the sun as a 'black body' with a surface temperature of about 6000° C. Being a black body, it emits light of all wave-lengths, but the wave-lengths in which we are particularly interested lie in the visible region from about 4000 A. to 7500 A., for it so happens that evolutionary processes have developed a human optical system which is most sensitive to such a band of wave-lengths.

When we measure the energy emitted by the sun within a small band of wave-lengths, for example, 10 A., and plot the energy as a function of the wave-length of this band of radiation, we obtain a curve with a pronounced maximum at about 5500 A., in the green. Again, the human eye is most sensitive in the region where the sun emits this maximum. Besides radiation in the visible region, there is also radiation at longer wave-lengths in the infra-red and at shorter wave-lengths in the ultra-violet. These radiations cannot be perceived by the human eye, but they can be detected by various physical methods.

It would seem, then, that the production of artificial illumination exactly similar to that of the sun is a simple matter. All we need do is to heat something black to a temperature of 6000° C. But the difficulty is that we cannot devise a means of heating a substance to this temperature, as all known materials either melt or volatilize so quickly that the conditions cannot be realized. Our problem, therefore, is to devise some subterfuge which will get over the difficulty without having to resort to the drastic method of getting radiation similar to that obtained from the sun. As a matter of interest, there is a possibility of doing better than the sun does. So far as illumination is concerned, the infra-red and ultra-violet radiation is wasted. If the energy of these rays could be converted into visible radiation, the efficiency of our source would be appreciably increased.

The goal to be obtained in the search for the ideal source of light is one in which all the energy supplied to the lamp, in whatever form, is wholly converted into visible radiation, with precisely the same intensity and wave-length distribution as that given by the sun. Dr. Melville gives an account of the progress that has been made towards this goal and how far we have still to go.

More than four thousand years ago, it was observed that certain vegetable and perhaps mineral oils, on undergoing combustion, emit visible radiation. Then by using a lamp into which a wick dipped, the burning was easily controlled at the top of the wick. Here then is the first principle of the subject—the conversion of oil into vapour and the subsequent combustion of the vapour. The next development was gas lighting. This phase occurred when it was found that oil could easily be converted into gas, and later when coal was found to undergo a similar reaction.

By allowing a substance to undergo combustion, a sufficiently high temperature is generated to produce visible radiation. If, therefore, we are going to increase the efficiency of our source of light, we must find out what produces the light. An experiment answers this question. The flame of a mixture of hydrogen and carbon monoxide emits only a small amount of radiation in the blue. When the gas is diverted through a bottle containing finely divided carbon, the flame becomes luminous and on close examination the incandescent particles of carbon can be seen describing vortices in the flame itself. The luminosity of the usual gas flame is thus due to carbon. The origin of the carbon in the gas flame is the decomposition of the volatile hydrocarbons present in the coal gas.

The temperature of even finely divided carbon in such a flame is only 1100° C., and therefore its colour does not approach that of the sun. Bunsen improved this by mixing the gas with air and by increasing its pressure. When mantles made of thorium and cerium are used, the light is the brightest. The curves obtained by the so-called Welsbach mixture show that the temperature attained is the highest. The light obtained from an ordinary gas mantle has a distinctly greenish tinge. This proves that it is no longer similar to a black body at the same temperature.

Besides the luminescence emitted by hot interacting gases, there are a number of solid and liquid reactions in chemistry which are accompanied by luminescence at ordinary temperatures. The luminescence of a firefly is a familiar example, but the precise nature of the reaction is not known. Unfortunately, one firefly gives only 1/1600 candle power, mostly in the green and red. For lighting a lecture room of reasonable size, about a million fireflies would be required.

Finally, the electrical methods of producing radiations are considered. The first attempts were

made by heating refractory materials by passing an electric current through them. The electric arc between carbon electrodes was one of the first satisfactory sources. Since the temperature of the carbon may reach 5000° C., the light is very similar in quality to that of the sun. But the efficiency is not high and the operation is too complicated for most purposes. The carbon filament incandescent lamp was a poor substitute, as in a high vacuum carbon volatilizes rather easily, with the result that the temperature is only about 1800° C. The tungsten filament was a great improvement, the working temperature of the filament rising to 2400° C. We can in this case use an inert gas like argon or nitrogen, thus making a lamp twice as efficient as the carbon filament lamp. A further improvement can be introduced by coiling the filament on itself.

A still more efficient lamp can be made by introducing a new method, namely, the phenomena accompanying electric discharge in rarefied gases. If a discharge tube be evacuated, it needs a very high potential difference applied across its terminals to produce a flash. By reducing the pressure to about 1/1000 of an atmosphere a much smaller voltage suffices to produce a steady discharge which fills the tube with light. A variety of colours can be obtained by using various gases instead of air. By constructing the interior of the lamp of fused silica and fixing a suitable conducting cathode, the pressure may be increased up to 100 atmospheres with a corresponding increase in luminous output.

The latest type of discharge lamp uses low-pressure discharge, in which the intensity of the ultra-violet radiation is a maximum, and a fluorescent substance which emits visible light under the action of ultra-violet light is put inside the tube. A series of such lamps can be devised with colours which when suitably blended give white light. To obtain white light from a single lamp, a mixture of powders is fused on to the inside of the discharge tube. The new discharge lamps have brought us very close to the perfectly efficient source.

SCIENCE AND THE COMMUNITY

A PUBLIC lecture "Science and the Community" given by Prof. Alex Findlay on September 12, 1938, at the invitation of the Council of the University of Otago, Dunedin, has been published by the New Zealand Council for Educational Research ("Studies in Education", No. 4. London: Oxford University Press). Referring to the achievements of applied science in ministering to the health and material comfort of the people and to industrial efficiency and development, Prof. Findlay points out that science is knowledge and that knowledge can be gained only by persistent inquiry or research, and he urges the importance for the welfare of the country that not merely a few but all the people should become research-minded and recognize with conviction that research is the best insurance of the future. Welcoming the greater attention being paid to the human factor in industry and to the consequences of the impact of science on our social organization, he considers that in proclaiming the great achievements of science we should beware of losing sight of the idealism of science. For the community as a whole, it is not the acquisition of a knowledge of scientific facts that is of chief importance but the inculcation of the spirit of science.

The first great aim of science is the seeking out of truth, and scientific truth is one of the great human values essential for a complete life. Science is, however, not merely an amassing of facts; its spirit is also to be found in the great hypotheses and theories of science, and the cultivation of the spirit of science makes an æsthetic as well as an intellectual appeal, strengthening and perfecting the fulfilment of that other essential factor in a complete human nature, the desire for beauty. Cultivation of the spirit of science is also necessary for the body politic. To cure or ameliorate the evils which flow from the weaknesses to which all democratic government is subject, we must work for a greater knowledge and honesty of purpose, a higher cultural level in the community.

Urging that science is an important factor in the moral and social development of the people, Prof. Findlay stresses the importance of ensuring that the minds of all university students should be opened to scientific truth as revealed in the physical and biological sciences and to recognize the importance of method and facts as well as ideas. For this he does not consider that laboratory work is essential. As regards the place of men of science in the State and in the general life of the community, he suggests that our present dangers are due to neglect of the ethical rather than of the scientific values. While he would not support any plea for a special place for the man of science as such in the councils of government, he urges the duty of men of science to cultivate a rich humanity and to educate their minds to take a wide view and form a balanced judgment, to enable them to take a much fuller share in the common duties of citizenship, placing more unreservedly at the disposal of their fellow citizens that contribution of special knowledge and outlook which their training and studies enable them to make. By cultivating the human values not only of science but also of art and religion, and building into their personalities the qualities of truth, beauty and goodness, scientific men can do much to form a more enlightened public opinion and help in the solution of the educational, social, economic and other problems which face the community. They should strive not merely to bring about a planned order of society with a purely materialistic outlook, but also an order in which individual human nature can find its full expression through the cultivation of truth, beauty and goodness.

UNIVERSITY EVENTS

ST. ANDREWS.—In view of the cancellation, owing to national emergency, of the graduation ceremonial appointed to be held by the University of St. Andrews on the occasion of the visit to Dundee of the British Association, the Senatus Academicus have conferred the honorary degree of LL.D. *in absentia* on the following, who were to be recipients of the degree upon that occasion: Prof. F. T. Brooks, Dr. C. G. Darwin, Sir Albert Seward, Prof. R. V. Southwell, Lord Stamp, Sir Aurel Stein.

Dr. Cyril Dodd, of Durham, has been appointed to the lectureship in natural philosophy in the United College, St. Andrews, which fell vacant on the appointment of Dr. F. L. Arnot to a post in Australia.

SCIENCE NEWS A CENTURY AGO

Travels of Schomburgk and Gould

IN its column of "Weekly Gossip" the *Athenæum* of October 5, 1839, referred to the naturalists Robert Schomburgk and John Gould.

Of the former the journal said: "We have also the pleasure to announce the arrival in London, after an absence of twelve years from Europe, of Mr. Robert Schomburgk, who, during the last four years has been engaged exploring in the colony of British Guiana under the auspices of the Geographical Society, in the course of which time he has twice ascended the Essequibo, and explored that river to its sources, about 40 miles north of the equator; he has also examined the Berbice and Coventyn rivers. . . . During his last journey, on which he was absent about two years in the interior, the traveller crossed the frontier to Fort San Joaquim in the Brazils, and ascended the Caruman mountains; thence returning to Pirára, he journeyed in a north-west direction to Roraima, a remarkable flat-topped sandstone mountain, rising 7,000 feet above the sea; and by a westerly course to Esmeralda, on the Orinoco, thereby connecting his labours with those of Baron Humboldt in the year 1800, and materially changing the position of the sources of that river as laid down in all our maps. Thence descending by the natural canal of the Cassiquiare to San Carlos, he embarked on the Rio Negro and followed its downward course as far as Moura, from which place he ascended the Rio Branco to San Joaquim thus completing a circle of upwards of 2,000 miles, a great part of which was through a country hitherto almost unknown. . . ."

Mr. (afterwards Sir) Robert Hermann Schomburgk was of German birth, being born in Prussia, June 5, 1804. After his explorations in the West Indies and British Guiana, he was appointed Government Commissioner for surveying and making the boundaries of British Guiana establishing the 'Schomburgk line'. Afterwards he was British Consul at San Domingo and at Bangkok. He died at Schöneberg, near Berlin, on March 11, 1865.

Of the naturalist John Gould the *Athenæum* said: "Mr. Gould, another of our enterprising naturalists, gone on a scientific pilgrimage to the very antipodes, and whose proceedings and success we have from time to time been enabled to announce to our readers, has, according to accounts just received, left Van Diemens Land for Southern Australia. He had already collected about 800 specimens of birds, 70 of quadrupeds (several of which are new), more than 100 specimens preserved whole in spirits for dissection, and the nests and eggs of above 70 species of birds, together with skeletons of all the principal forms".

Born at Lyme Regis on September 14, 1804, Gould as a boy lived with his uncle at the royal gardens at Windsor. In 1827 he became taxidermist to the Zoological Society and during the years 1831–37 published works on the birds of the Himalayas and of Europe, the drawings for which were made by his wife, who in 1838 accompanied her husband to Australia, where she died. Gould returned to England in 1840 and afterwards published "The Birds of Australia", "The Mammals of Australia", "A Handbook of Birds of Australia" and "The Birds of Great Britain". He was elected F.R.S. in 1843 and died in London on February 3, 1881.

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